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Efficacy and Safety of Paravertebral Ozonated Water Injection Combined with Spinal Nerve Root Radiofrequency Ablation in the Treatment of Postherpetic Neuralgia

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Abstract

Objective: To evaluate the efficacy and safety of paravertebral ozonated water injection combined with spinal nerve root radiofrequency ablation in the treatment of postherpetic neuralgia. **Methods:** A total of 80 patients with postherpetic neuralgia admitted to our hospital from July 2023 to July 2025 were enrolled and randomly divided into two groups (n = 40 each) using a random number table method. The control group received spinal nerve root radiofrequency ablation alone, while the study group received paravertebral ozonated water injection combined with spinal nerve root radiofrequency ablation. Pain scores and sleep disturbance scores at different time points before and after treatment were compared between the two groups, and complications were recorded. **Results:** At 2 weeks, 4 weeks, and 3 months after treatment, both pain scores and sleep disturbance scores in the two groups were significantly reduced compared with those before treatment. Moreover, the scores at all post-treatment time points in the study group were lower than those in the control group. The incidence of complications in the study group was also lower than that in the control group, with statistically significant differences ($P < 0.05$). **Conclusion:** For patients with postherpetic neuralgia, paravertebral ozonated water injection combined with spinal nerve root radiofrequency ablation can significantly alleviate postoperative pain and reduce the severity of sleep disturbances, demonstrating high treatment safety and favorable therapeutic efficacy.

Keywords

Paravertebral ozonated water injection; spinal nerve root radiofrequency ablation; combination therapy; postherpetic neuralgia

Postherpetic neuralgia is a neuropathic pain condition caused by reactivation of latent varicella–zoster virus infection, which severely affects patients' quality of life [1]. Spinal nerve root radiofrequency ablation relieves pain by interrupting nerve conduction through thermal coagulation. However, a single treatment modality often shows limited efficacy, whereas the combination of paravertebral ozonated water injection and spinal nerve root radiofrequency ablation provides a new therapeutic strategy for this condition [2]. Paravertebral ozonated water injection exerts anti-inflammatory and analgesic effects and promotes nerve repair. It can improve local tissue oxygen supply, regulate immune function, and reduce neuroinflammatory responses. The combined use of these two approaches produces a synergistic effect, intervening in postherpetic neuralgia through different mechanisms [3]. Based on the above findings, this study selected patients with this condition recently treated in our hospital and administered different therapeutic regimens. The results are reported as follows:

1. Materials and Methods

1.1 General Information

Inclusion criteria: (1) Patients met the diagnostic criteria for postherpetic neuralgia according to the Chinese Medical Association guidelines; (2) age 18-80 years; (3) provision of informed consent.
Exclusion criteria: (1) Poor treatment compliance; (2) presence of severe organ diseases.

In the study group, aged 36.0-73.0 years, with a mean age of (57.37 ± 4.15) years. In the control group, aged 38.0-74.0 years, with a mean age of (58.09 ± 4.22) years. There was no statistically significant difference in general characteristics between the two groups ($P > 0.05$). This study was conducted with approval from the Medical Ethics Committee of our hospital.

1.2 Methods

Control group: Spinal nerve root radiofrequency ablation was performed. Patients were placed in the prone position, and routine disinfection and draping were conducted. Under CT guidance (Germany, Siemens), the responsible nerve root was identified. After local infiltration anesthesia, a radiofrequency needle was inserted percutaneously to the target nerve root (Beiqi Radiofrequency Temperature-Controlled Thermocoagulator, R-2000B A1). Electrical stimulation testing was performed after correct needle placement to confirm accurate positioning and ensure no injury to surrounding critical tissues. Appropriate radiofrequency parameters were set (temperature 60-80 °C, duration 60-120 s) to perform radiofrequency ablation of the nerve root. After the procedure, the radiofrequency needle was removed, local compression was applied for hemostasis, and the puncture site was disinfected and covered with a sterile dressing.
Study group: Paravertebral ozonated water injection combined with spinal nerve root radiofrequency ablation was performed.

First, paravertebral ozonated water injection was administered. Ozonated water with a concentration of 20-40 μg/mL was prepared (German OZOMED ozone therapy device by Kater). The paravertebral interspace corresponding to the affected vertebral body (with a clear interspace, no obstruction by major vessels or nerves, and proximity to the lesion area) was selected as the puncture site. The injection dose was determined based on body weight, disease severity, and lesion extent. For patients with lower body weight, milder disease, and smaller lesion range, the initial dose was set at 5-10 mL; for patients with higher body weight, more severe disease, and wider lesion involvement, the dose was increased to 10-20 mL.

Patients were placed in the prone position with soft cushions under the chest and iliac regions to maintain comfort and stability. Routine disinfection and sterile draping were then performed, centering on the puncture point and extending outward with a disinfection diameter >15 cm, followed by placement of a sterile fenestrated drape. Under CT guidance, the puncture angle and depth were planned first. A radiofrequency thermocoagulation electrode cannula needle was then inserted percutaneously. The needle trajectory was monitored in real time by CT scanning to advance the needle to the vicinity of the spinal nerve root corresponding to the lesion. After aspiration confirmed the absence of blood or cerebrospinal fluid, the prepared ozonated water was slowly injected at a rate not exceeding 5 mL/min.

After the injection, the patient was observed for discomfort. Finally, spinal nerve root radiofrequency ablation was performed using the same method as in the control group.

1.3 Evaluation Criteria

Pain scores and sleep disturbance scores at different time points before and after treatment were compared between the two groups, and complications were recorded. Pain was assessed using the Visual Analog Scale (VAS), where 0 indicates no pain, and 10 indicates the most severe pain. Sleep disturbance was evaluated using the Pittsburgh Sleep Quality Index (PSQI), with a total score range of 0-21 points; higher scores indicate poorer sleep quality. Pain and sleep scores were assessed before treatment and at 2 weeks, 4 weeks, and 3 months after treatment. Complications such as bleeding, infection, arrhythmia, and aggravated pain were also recorded [4, 5].

1.4 Statistical Methods

Statistical analysis was performed using SPSS version 25.0. Measurement data conforming to a normal distribution were expressed as $\bar{x} \pm s$, and intergroup comparisons were performed using the *t*-test. Count data were expressed as cases (*n*) and percentages (%), and comparisons between groups were conducted using the chi-square test. A value of $P < 0.05$ was considered statistically significant.

2. Results

2.1 Comparison of Pain Scores and Sleep Disturbance Scores Between the Two Groups at Different Time Points Before and After Treatment

There was no statistically significant difference in pain scores or sleep disturbance scores between the two groups before treatment ($P > 0.05$). At 2 weeks, 4 weeks, and 3 months after treatment, both pain scores and sleep disturbance scores in the two groups were significantly reduced compared with pre-treatment levels. Moreover, the scores at all post-treatment time points in the study group were lower than those in the control group, and the differences were statistically significant ($P < 0.05$) (see Table 1).

Table 1. Comparison of Pain Scores and Sleep Disturbance Scores Between the Two Groups at Different Time Points Before and After Treatment [($\bar{x} \pm s$), points]

Group	Pain						
	Before treatment	2 weeks after treatment	4 weeks after treatment	3 months after treatment	t/P (Before vs. 2 weeks)	t/P (Before vs. 4 weeks)	t/P (Before vs. 3 months)
Study group (n = 40)	7.43±1.35	4.95±0.52	3.37±1.01	1.92±0.27	7.815/ < 0.05	9.575/ < 0.05	15.409/ < 0.05
Control group (n = 40)	8.48±1.46	6.43±0.77	4.85±0.96	2.86±0.55	4.808/ < 0.05	7.765/ < 0.05	11.374/ < 0.05
t	0.428	6.361	7.462	4.777	-	-	-
P	> 0.05	< 0.05	< 0.05	< 0.05	-	-	-
Group	Sleep Disturbance						
	Before treatment	2 weeks after treatment	4 weeks after treatment	3 months after treatment	t/P (Before vs. 2 weeks)	t/P (Before vs. 4 weeks)	t/P (Before vs. 3 months)
Study group (n = 40)	16.57±1.46	10.75±1.72	8.97±1.61	6.69±1.18	9.587/ < 0.05	13.407/ < 0.05	18.613/ < 0.05
Control group (n = 40)	16.63±1.32	12.93±1.27	10.85±1.26	8.25±1.37	6.473/ < 0.05	9.528/ < 0.05	12.881/ < 0.05
t	0.743	6.173	0.790	0.475	-	-	-
P	> 0.05	< 0.05	< 0.05	< 0.05	-	-	-

2.2 Comparison of Complications Between the Two Groups

The incidence of complications in the study group was lower than that in the control group, and the difference was statistically significant ($P < 0.05$) (see Table 2).

Table 2. Comparison of Complications Between the Two Groups [n, (%)]

Group	n	Bleeding	Infection	Arrhythmia	Pain aggravation	Total
Study group	40	1 (2.50)	0 (0.00)	0 (0.00)	0 (0.00)	1 (2.50)
Control group	40	3 (7.50)	1 (2.50)	1 (2.50)	3 (7.50)	8 (20.00)
χ^2						5.982
P						< 0.05

3. Discussion

The primary goals in the treatment of postherpetic neuralgia are to achieve early and effective pain control, relieve sleep and emotional disturbances, and improve quality of life. Pharmacological therapy has certain limitations, and pain relief remains the foremost indicator for evaluating therapeutic efficacy [6]. Spinal nerve root radiofrequency ablation has a unique mechanism in treating this condition, as it can precisely interrupt the transmission of pain signals to alleviate symptoms. However, the procedure carries potential risks, including damage to surrounding nerve

tissues and the occurrence of complications, and some patients may experience postoperative pain recurrence [7]. Paravertebral ozonated water injection represents a novel therapeutic approach. Ozonated water exhibits anti-inflammatory and analgesic effects and can improve local blood circulation. Injection into the paravertebral region can reduce inflammation, relieve nerve compression, and promote recovery of nerve function. When combined with spinal nerve root radiofrequency ablation, a synergistic therapeutic effect can be achieved [8].

In this study, at 2 weeks, 4 weeks, and 3 months after treatment, both pain scores and sleep disturbance scores in the two groups were significantly lower than those before treatment, and the scores at all time points in the study group were lower than those in the control group, with statistically significant differences ($P < 0.05$). This may be attributed to the strong oxidative effect of paravertebral ozonated water injection, which can improve local tissue blood circulation, promote the absorption and resolution of inflammation, and reduce edema of the nerve root, thereby effectively relieving pain [9]. Meanwhile, ozonated water can regulate immune function and enhance the body's resistance to viral infection, helping to control the replication and spread of varicella–zoster virus. In contrast, spinal nerve root radiofrequency ablation achieves analgesia by inducing thermal degeneration of the nerve root and blocking the transmission of pain signals. The combined application of these two therapies not only treats the disease by improving the local microenvironment and modulating immune function but also directly interrupts pain signal transmission, producing a synergistic effect and substantially enhancing therapeutic efficacy.

Furthermore, the incidence of complications in the study group was lower than that in the control group, with a statistically significant difference ($P < 0.05$). Compared with spinal nerve root radiofrequency ablation alone, the combined therapy demonstrated clear advantages. Although radiofrequency ablation alone can directly block pain signal conduction, it mainly addresses symptomatic pain and does not fundamentally improve local inflammation, edema, or the immune status of the body [10]. In addition, radiofrequency ablation may cause a certain degree of nerve root injury. If the local tissue environment is poor—such as in the presence of severe inflammation and edema—the risk of nerve damage and complications may increase. The addition of paravertebral ozonated water injection can improve local tissue conditions, reduce inflammation and edema, create more favorable conditions for radiofrequency ablation, decrease the risk of nerve injury, and lower the incidence of complications, thereby enhancing both the safety and effectiveness of treatment.

In summary, for patients with postherpetic neuralgia, treatment with paravertebral ozonated water injection combined with spinal nerve root radiofrequency ablation can significantly reduce postoperative pain and the severity of sleep disturbances, with high safety and favorable clinical efficacy.

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