

## Randomized Controlled Trial

# Effects of Dexamethasone Administration in Sphenopalatine Ganglion Block for Allergic Rhinitis: A Prospective, Randomized, Single-blind Controlled Trial

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**Background:** Allergic rhinitis (AR) is a common chronic condition that significantly affects quality of life. Ultrasound-guided sphenopalatine ganglion block (SPGB) is a minimally invasive, safe, and effective treatment gaining clinical attention for symptom relief. Dexamethasone is often used in an SPGB, but its effect on autonomic nerve modulation remains unclear.

**Objectives:** This study aimed to assess the therapeutic effect of ultrasound-guided SPGB for treating AR and to compare the clinical efficacy and adverse reactions of dexamethasone used in conjunction with an SPGB.

**Study Design:** A prospective, randomized, single-blind controlled trial.

**Setting:** Nanjing Drum Tower Hospital Clinical College of Xuzhou Medical University, People's Republic of China.

**Methods:** This randomized clinical trial, involving 84 patients with AR, was conducted at Nanjing Drum Tower Hospital from February 2024 through May 2024. Patients were randomly assigned to either the experimental group (42 patients) or the control group (42 patients), with blinding applied. A total of 78 patients completed the study (40 in the experimental group, 38 in the control group). Both groups received an ultrasound-guided SPGB once a week for 4 weeks, alternating sides. The experimental group was treated with a combination of bupivacaine and dexamethasone, while the control group received only bupivacaine. Changes in efficacies, Total Nasal Symptom Score (TNSS), nasal symptom Visual Analog Scale (VAS), Rhino-conjunctivitis Quality of Life Questionnaire (RQLQ) scores, Total Nasal Respiratory Volume (TNRV), Total Nasal Volume (TNV), and Total Nasal Resistance (TNR) were measured at pretreatment and at one week, one month, 3 months, and 6 months posttreatment. Additionally, effective rate was calculated as the percentage of patients achieving a clinically meaningful response, defined as a reduction in TNSS of 30% or greater from baseline.

**Results:** Both groups had significant reductions in TNSS, nasal symptom VAS, and RQLQ scores compared to pretreatment levels at all follow-up points ( $P < 0.001$ ). At one week, one month, and 3 months posttreatment, the experimental group had higher efficacies, lower TNSS, lower VAS, and lower RQLQ scores than the control group ( $P < 0.05$ ). At 6 months posttreatment, there were no significant differences between the groups for efficacy rates, VAS, or RQLQ scores ( $P > 0.05$ ) while the experimental group had lower TNSS scores ( $P < 0.05$ ). Both groups had significant improvement in nasal ventilation, with increases in TNRV and TNV and reductions in TNR ( $P < 0.001$ ). At each follow-up, the experimental group had higher TNRV and TNV and lower TNR compared to the control group, with statistical significance observed at most time points ( $P < 0.05$ ), except for TNRV at 6 months and TNV at 3 and 6 months posttreatment. Safety indicators showed no significant differences between groups ( $P > 0.05$ ).

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**Limitations:** We did not assess patient depression and anxiety; how dexamethasone over triamcinolone potentially affected efficacy; and how the absence of 3D navigation would have resulted in a safer, more precise block.

**Conclusions:** Ultrasound-guided SPGB is a safe and effective treatment for AR, improving symptoms, quality of life, and nasal airflow. The addition of corticosteroids may enhance short-term efficacy.

**Key words:** Block, sphenopalatine ganglion, allergic rhinitis, dexamethasone, neuromodulation, Total Nasal Symptom Score, clinical trial, interdisciplinary research

**Clinical trials registration and ethics approval:** Chinese Clinical Trial Registration Center (www.chictr.org.cn; ChiCTR240088205); ethics approval number by Ethics Committee of Nanjing Drum Tower Hospital: 2023-510-02

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**A**llergic rhinitis (AR) is a noninfectious nasal inflammation triggered by an immune response to allergens mediated by immunoglobulin E, (ranking among the most prevalent chronic disorders globally and significantly affecting patients' quality of life (1,2). Standardized drug therapy or immunotherapy constitutes the primary treatment for AR. Treatment typically involves the use of glucocorticoids and antihistamines, as recommended by clinical guidelines (3). However, adverse reactions to glucocorticoids often occur. These reactions include nasal bleeding, a nasal burning sensation, alterations in taste, and in severe cases, perforation of the nasal septum (4). Antihistamine drugs frequently result in dizziness, drowsiness, fatigue, etc., which tend to affect daily work and activities of daily living (5). Consequently, due to environmental factors, prolonged treatment durations, reduced medication adherence, and irreversible nerve damage from surgical interventions, many patients experience uncontrolled symptoms or only temporary relief (e.g., immediate recurrence after stopping medication) (6,7). One study found that approximately 18.9% of patients fall into this category (7). There is a pressing need for novel, safe, and effective therapeutic options.

Research has indicated that dysfunction of the autonomic nervous system serves as a fundamental basis for AR, characterized by an imbalance between the sympathetic and parasympathetic branches (8,9). The sphenopalatine ganglion, the largest parasympathetic ganglion in the human body, innervates crucial structures, including the lacrimal glands, nasal mucosa, paranasal sinuses, pharyngeal salivary glands, and nasal mucosa blood vessels, making it a significant target for therapeutic intervention for AR (10).

Interventions targeting the sphenopalatine ganglion primarily encompass 2 modalities: acupuncture and nerve blockade. In 2015, the American Academy of Otolaryngology-Head and Neck Surgery recognized sphenopalatine ganglion acupuncture as one of several treatment options for AR (11). Successful acupuncture is performed by needle placement within the sphenoid fossa, resulting in immediate sensations of electrical discharge, numbness, and tingling in facial regions such as the eyes, nose, mouth, lips, teeth, and even unilaterally on one side of the face (12,13). However, due to challenges associated with operational complexity, and substantial stimulation intensity leading to patient discomfort and poor compliance rates, this technique has not been widely used (14).

An ultrasound-guided sphenopalatine ganglion block (SPGB) facilitates drug diffusion to the ganglion, reduces puncture difficulty, minimizes nerve stimulation, and decreases patient discomfort, making the procedure more acceptable to patients. A study (15) has demonstrated that SPGB is effective for managing AR, potentially offering sustained symptom relief while decreasing patients' reliance on pharmacotherapy. Additionally, the 2022 Chinese Rhinitis Guideline (16) emphasizes the importance of neurostimulation therapy in treating nasal disorders, describing it as a straightforward, safe, and effective approach with lasting benefits.

A nerve block, such as a stellate ganglion block and lumbar sympathetic ganglion block, effectively modulate autonomic dysfunction by regulating the sympathetic-parasympathetic balance and enhancing vascular vasomotor function (17,18). Guidelines recommend using pure local anesthetics for these autonomic regulation injections (19). At present, the drugs used

in the related research of SPGB are all local anesthetics combined with glucocorticoids. The formulation of drugs for SPGB mainly relies on the experience of the interventionalist. Glucocorticoids are considered one of the most effective drugs for treating AR. They alleviate symptoms by inhibiting inflammatory and immune responses, reducing vascular permeability, alleviating tissue edema, decreasing secretions, and improving ventilation (20). However, it remains unclear whether glucocorticoids enhance autonomic nerve function regulation. Our study mainly explored the effectiveness and safety of using glucocorticoids for SPGB for treating AR.

## METHODS

### Research Design and Ethics

This prospective, randomized, single-blind controlled trial included 84 patients with AR. It was conducted from February 2024 through May 2024 at the Pain Clinic of Nanjing Drum Tower Hospital. The study protocol was approved by the Ethics Committee of Nanjing Drum Tower Hospital (ethics approval number: 2023-510-02). The clinical trial registration number is ChiCTR240088205. All patients freely signed an informed consent form.

The sample size was calculated using an efficient ( $\geq 30\%$ ) method (21). Preliminary results indicated that the effective rates for the treatment group and control group were 89% and 66%, respectively, after one week of treatment. A one-sided z-test was used with an 80% power and an  $\alpha$  value of 0.05, with a 1:1 allocation ratio. Using Power Analysis and Sample Size 15.0 software (NCSS Statistical Software), the initial sample size was determined to be 76; taking into account a 10% dropout rate, the adjusted sample size was 84. The patients were recruited through a combination of referrals from a specialist in rhinology and advertisements on social media platforms.

Inclusion criteria were: 1) a diagnosis of AR per clinical guidelines, with primary nasal symptoms occurring for more than 4 days per week lasting over 4 weeks (22,23); 2) an ineffective response to corticosteroids, antihistamines, or immunotherapy; 3) Average Total Nasal Symptom Score (TNSS) of  $\geq 4$  during the week prior to treatment; 4) aged 18 to 60 years who were able to provide informed consent and agree to participate.

Exclusion criteria included: 1) nasal polyps, sinusitis, significant septal deviation, or other nasal struc-

tural diseases; 2) asthma or other episodic respiratory diseases; 3) a previous pterygopalatine nerve section, greater petrosal nerve section, or turbinate surgery; 4) pregnant, breastfeeding, or planning pregnancy during treatment; 5) psychiatric disorders or inability to comply with treatment; 6) bleeding tendencies, coagulation disorders, or diabetes mellitus.

### Randomization and Blinding

Randomization was performed using a random number table, generated by an independent statistician. Allocation concealment was ensured by using sealed opaque envelopes containing the randomization sequence, which were opened only after patient enrollment. Patients were enrolled by a specialist in rhinology who was not involved in the randomization process. After enrollment, patients were assigned to either the experimental or control group by a separate team member, who was blinded to the group assignment. The trial was single-blind, with patients remaining unaware of their group assignment throughout the study. The study protocol is shown in Fig. 1.

### Procedure

Patients who met the inclusion criteria received treatment in an outpatient clinic. Basic vital signs were monitored, and if they were normal, an SPGB was performed (Fig. 2). All procedures were performed by the same attending physician.

The patient was placed supine with the head turned to the opposite side, and the injection site area was sterilized and covered. A high-frequency ultrasound probe was positioned in front of the zygomatic arch and moved laterally toward the tail, scanning from the condyle to the coronoid process. Below the condyle, the masseter, zygomaticus, and medial pterygoid muscles are visible, while the pterygoid canal is located above the condyle. The probe was slightly tilted upward and slightly forward, and the patient was asked to slightly open their mouth, causing the coronoid process to disappear, revealing the lateral plate of the zygomatic bone and the pterygoid fossa, which is formed by the zygomatic bone and the pterygoid muscle.

Under ultrasound guidance, a 7G needle was inserted from the frontal plane into the pterygoid fossa, targeting the pterygopalatine ganglion, and a mixture of solutions was injected. In the experimental group, an injectate of 0.75% saline bupivacaine 1.5 mL plus dexamethasone sodium phosphate 5 mg and 0.9% sodium chloride 2.5 mL, a total of 5 mL, was used. In the

control group, the injectate included 1.5 mL of 0.75% saline bupivacaine and 3.5 mL of 0.9% sodium chloride, also totaling 5 mL. Both sides were alternated, once a week, for a total of 4 weeks per treatment course. Both

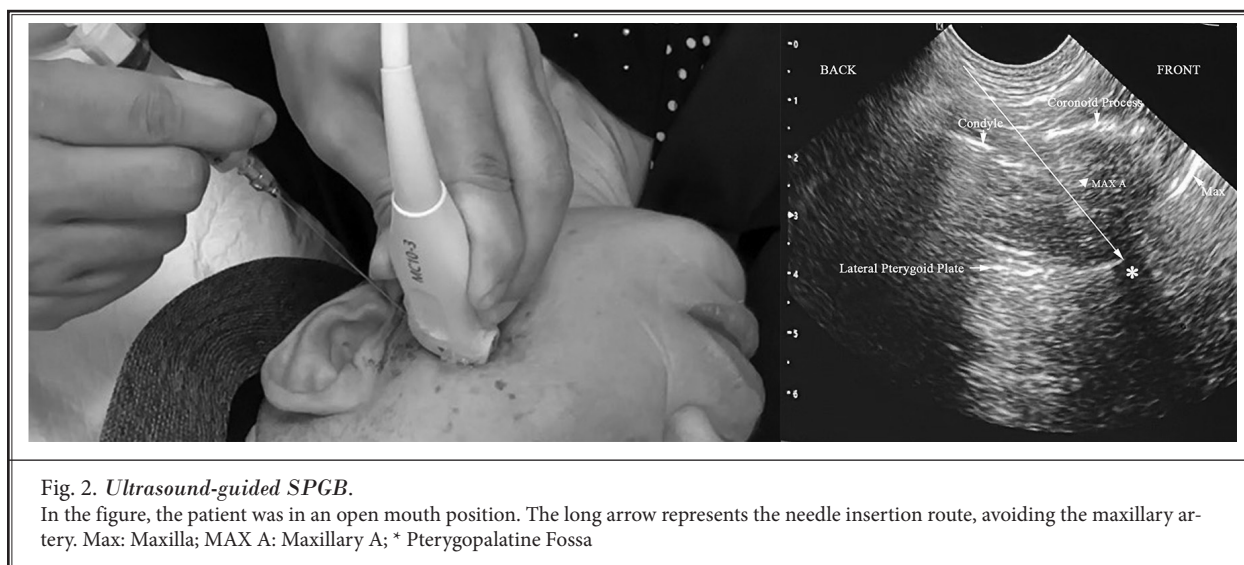
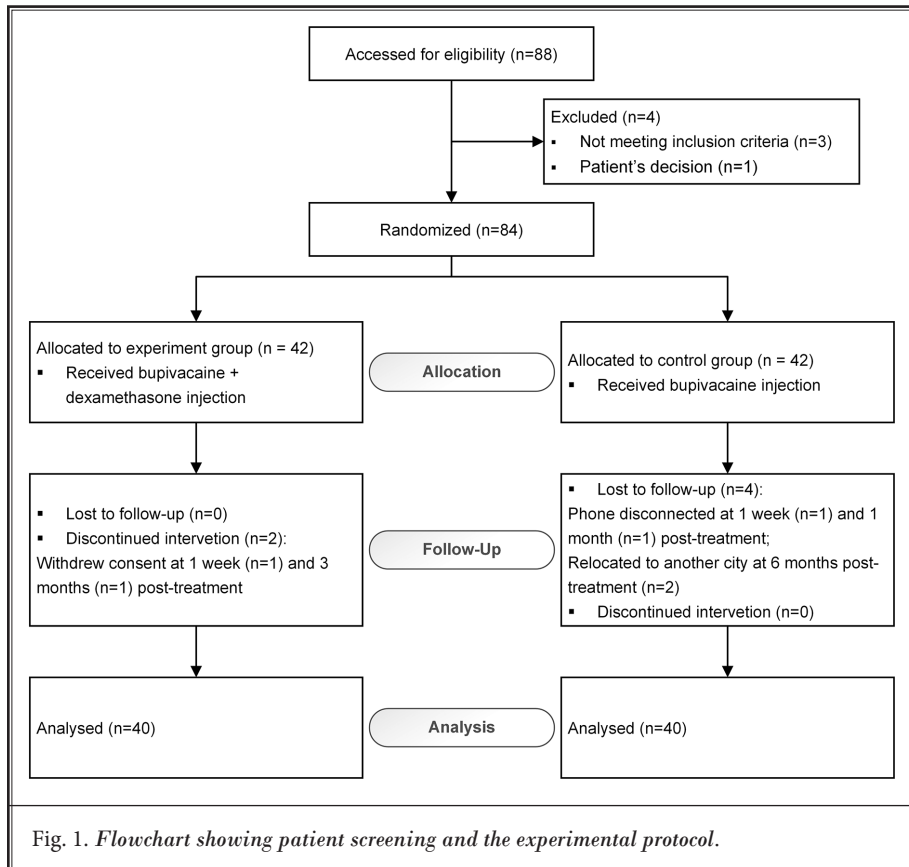
groups received identical medication in terms of color, shape, volume, administration route, frequency, and treatment protocol.

The SPGB has evolved into a well-established

technique widely used for managing sphenopalatine neuralgia, as well as for anesthesia and analgesia during nasal and palatal surgeries, treating facial paralysis, and alleviating postdural puncture headache. Performing an outpatient sphenopalatine ganglion block has become a standard therapeutic practice. All patients who received this procedure in our outpatient clinic were monitored for 30 minutes before being discharged.

### Outcome Measurements

Outcome measurements were recorded at pretreatment and at one week, one month, 3 months, and 6 months posttreatment.



### Primary Outcome

The TNSS evaluates 4 key symptoms: nasal congestion, rhinorrhea, sneezing, and nasal itching. Each symptom's severity is rated from 0 to 3, where 0 indicates no symptoms and 3 signifies the most severe symptoms. The TNSS is the cumulative score, reflecting the overall severity of nasal symptoms and providing a comprehensive reflection of the overall severity of a patient's nasal symptoms (11). A good treatment response is indicated by an improvement in the TNSS score. Typically, an improvement of  $\geq 30\%$  in the TNSS is considered effective treatment. The calculation is: effective rate = (pretreatment TNSS - posttreatment TNSS) / pre-treatment TNSS  $\times 100\%$  (21). Our trial considered an effective rate as the primary outcome.

### Other Outcomes

Patients reported the severity of their nasal symptoms (nasal congestion, rhinorrhea, sneezing, nasal itching) on a Visual Analog Scale (VAS) from 0 to 10, where 0 denoted no symptoms and 10 represented the most severe symptoms (24).

The Rhino-conjunctivitis Quality of Life Questionnaire (RQLQ) assesses the effect of AR on a patient's quality of life across 7 domains: nasal symptoms, eye symptoms, nonnasal/eye symptoms, sleep problems, activity limitations, emotional impact, and practical problems. Patients rate their experiences over the past week on a one to 7 scale, where one means no impact and 7 signifies severe impact (25).

Nasal function was evaluated through 3 objective methods: Total Nasal Respiratory Volume (TNRV), Total Nasal Volume (TNV), and Total Nasal Resistance (TNR). During each assessment time point, all 3 objective measurements (TNRV, TNV, and TNR) were performed consecutively by the same trained technician within a

single 30-minute session to minimize the influence of the nasal cycle. Patients rested in a room with appropriate temperature and humidity to eliminate the effects of humidity, temperature, noise, and activity on the nasal mucosa. Objective indicators on nasal function were recorded at pretreatment and at one week, one month, 3 months, and 6 months posttreatment.

Nasal Respiratory Volume (NRV) (Fig. 3A) was measured using a nasal respiratory volume instrument. Two flow collectors were placed at both nostrils, ensuring a secure fit without altering nasal shape. Patients were told to breathe calmly while inspiratory and expiratory volumes from both nostrils were recorded for 20 seconds. TNRV was calculated as the sum of these volumes (L/20s) (26).

Nasal reflex was assessed using a nasal reflex instrument; a nasal probe was lightly placed against one nostril to maintain a sealed state. The patients were told to breathe calmly. The instrument recorded sound wave reflections, generating a curve showing nasal cavity cross-sectional areas. The TNV from 0–7 cm was measured ( $\text{cm}^3$ ) (27) (Fig. 3B).

Nasal resistance was assessed using a nasal resistance instrument through anterior rhinomanometry. Patients wore a nasal mask over one nostril, while the other nostril was sealed with a mask. The instrument generated a resistance-flow curve to record total nasal resistance TNR at a pressure difference of 150 Pa ( $\text{KPa/L/s}$ ) (28) (Fig. 3C).

### Safety

Safety was assessed by monitoring complications related to both puncture and drug injection pre- and postprocedure. Puncture-related issues included hematoma, oral puncture, infection at the puncture site, and nasal bleeding. Injection-related complications in-



Fig. 3. A: nasal respiratory volume; B: nasal reflex; C: nasal resistance

cluded hypotension, dizziness, local anesthetic toxicity, and allergic reactions.

### Statistical Analyses

Statistical analyses were performed using the IBM SPSS Statistics 26.0 (IBM Corporation). Normality of continuous variables was assessed with the Shapiro-Wilk test, while homogeneity of variances was evaluated using Levene's test.

Baseline comparisons: Normally distributed variables (e.g., TNRV, TNV, TNR) are presented as mean  $\pm$  SD and compared with *t* tests; categorical variables (e.g., gender) as percentages and compared with  $\chi^2$  or Fisher's exact tests; non-normally distributed variables (e.g., TNSS, VAS) as median (interquartile range) and compared with Mann-Whitney U tests.

For continuous variables, including TNSS, VAS, and RQLQ, results are expressed as mean  $\pm$  SD. Considering the effects of group, time, and their interaction on the response variable, generalized estimating equations were employed for comparisons. Comparisons over time and group were conducted using generalized estimating equations, assuming a normal distribution with an identity link, and specifying an independent working correlation matrix to account for within-subject correlations.

For categorical variables, such as the treatment efficacy rate of TNSS and the incidence of adverse reactions, results are expressed as percentages (%). Fisher's exact tests or  $\chi^2$  tests were used for between-group comparisons.

When multiple comparisons were performed, the significance level was adjusted using Bonferroni correction to control for type I error. The CI was set at 95%. A *P* value  $< 0.05$  was deemed statistically significant.

## RESULTS

### Patient Characteristics

A total of 84 patients were included in our study. Patients were randomly divided into 2 groups—42 in each group. There were no significant differences between the 2 groups regarding age, gender, disease duration, and AR symptom index ( $P > 0.05$ ) (Table 1), indicating homogeneity. A total of 78 patients completed all treatments and follow-ups—40 in the experimental group and 38 in the control group. Six patients were lost to follow-up (Fig. 1).

### Clinical Efficacy Evaluation

Our trial results showed a significant interaction

effect between group and time for TNSS, VAS of 4 nasal symptoms, RQLQ scores, TNRV, TNV and TNR, suggesting that changes over time differed between the experimental and control groups and warranting an analysis of individual effects. (Figs. 4–7)

### Primary Outcome

At one week, one month, and 3 months posttreatment, the experimental group had a significantly higher effective rate than the control group (odds ratio: 5.091, 3.306, 2.788, respectively,  $P < 0.05$ ), with minimal overlap in the 95% CIs (Table 2). However, at 6 months, although the experimental group's effective rate remained higher (62.50% vs 50.00%), the overlap in the 95% CI and a *P* value of 0.266 indicated no significant difference. Despite a significant change in TNSS scores at 6 months ( $P = 0.011$ ), the improvement did not meet the clinical efficacy threshold, meaning no significant clinical benefit was observed (Table 2, Fig. 4). Both groups significantly reduced their TNSS from baseline (experimental group:  $7.63 \pm 0.211$  to  $5.05 \pm 0.137$ ; control group:  $7.92 \pm 0.205$  to  $5.76 \pm 0.245$ ). At one week, one month, 3 months, and 6 months posttreatment, TNSS for the experimental and control groups were as follows: 3.88 vs 5.16; 4.05 vs 5.21; 4.38 vs 5.58; and 5.05 vs 5.76, respectively ( $P < 0.05$ ).

### Other Outcomes

The analysis of time effect alone showed that VAS for nasal symptoms in both groups was significantly lower at all follow-up points compared to baseline ( $P < 0.001$ ). Regarding group effect, early posttreatment time points (one week, one month, and 3 months) had significantly lower VAS scores in the experimental group than in the control group ( $P < 0.05$ ). At the 6-month follow-up, although the VAS in the experimental group remained lower than those in the control group, this difference was not statistically significant ( $P > 0.05$ ). These findings indicate that while the experimental group showed superior efficacy in alleviating nasal symptoms at early time points, the difference between the 2 groups diminished over time (Table 3 and Fig. 5).

RQLQ scores followed a trend similar to the VAS for nasal symptoms, with both groups showing that an SPGB effectively improved their quality of life. Additionally, the quality of life in the experimental group was better than in the control group at earlier time points, but by the 6-month follow-up, the therapeutic effects in both groups gradually converged (difference: 4.103, 95% CI, -0.101 to 8.306;  $P = 0.056$ ) (Table 3 and Fig. 6).

The results (Table 3 and Fig. 7A) indicate that SPGB treatment significantly increased TNRV in both groups (experimental group: from 3.56 to 4.51; control group: from 3.69 to 4.14,  $P < 0.001$ ), with greater improvement in the experimental group at early posttreatment time points (one week, one month, and 3 months) compared to the control group (5.11 vs 4.53; 5.48 vs 4.52; and 5.16 vs 4.46 respectively,  $P < 0.05$ ). At 6 months posttreatment, although the TNRV in the experimental group remained higher than that in the control group, the difference had decreased and was no longer statistically significant (difference: -0.37, 95%CI, -0.93 to 0.18,  $P = 0.190$ ).

Meanwhile, SPGB also significantly increased the TNV in both groups (experimental group: from 16.47 to 17.38; control group: from 16.08 to 17.08,  $P < 0.001$ ). Compared to the control group, TNV in the experimental group increased significantly, with statistically significant differences at one week and one month posttreatment (18.91 vs 17.51, 18.67 vs 17.37,  $P < 0.05$ ). However, at 3 months and 6 months posttreatment, the difference between the groups was no longer significant (difference: -0.86, 95% CI, -2.05 to 0.34,  $P = 0.160$ ; difference: -0.29, 95%CI, -1.43 to 0.84,  $P = 0.611$ ) (Table 3 and Fig. 7B).

SPGB significantly reduced TNR in both groups (experimental group: from 0.369 to 0.249; control group: from 0.356 to 0.287,  $P < 0.001$ ), with TNR in the experimental group consistently lower than in the control group at all 4 follow-up points ( $P < 0.05$ ) (Table 3 and Fig. 7C).

### Safety Evaluation

In the experimental group, 2 patients experienced facial swelling, while 3 patients in the control group reported the same. There was no statistically significant difference in facial edema incidences between the 2 groups ( $P > 0.05$ ). One patient in each group experienced

Table 1. Demographic data for the patients in each group.

|                        | Experimental Group | Control Group | Overall       | Statistic  | P Value            |
|------------------------|--------------------|---------------|---------------|------------|--------------------|
|                        | (n = 40)           | (n = 38)      | (n = 78)      |            |                    |
| Age(years)             | 36.98 ± 11.39      | 36.84 ± 10.30 | 36.91 ± 10.80 | t = 0.054  | 0.957 <sup>a</sup> |
| Gender                 |                    |               |               | -          | 1.000 <sup>b</sup> |
| Men                    | 21.0 (52.5%)       | 20.0 (52.6%)  | 41.0 (52.6%)  |            |                    |
| Women                  | 19.0 (47.5%)       | 18.0 (47.4%)  | 37.0 (47.4%)  |            |                    |
| Course(years)          | 5 (3,10)           | 5 (2,10)      | 5 (3,10)      | Z = -0.354 | 0.723 <sup>c</sup> |
| TNSS                   | 8 (5, 10)          | 8 (6, 10)     | 8 (5, 10)     | Z = -0.948 | 0.343 <sup>c</sup> |
| VAS                    |                    |               |               |            |                    |
| Nasal congestion       | 6 (2, 9)           | 6.50 (3, 9)   | 6 (2, 9)      | Z = -0.865 | 0.387 <sup>c</sup> |
| Sneezing               | 4 (2, 8)           | 5 (2, 8)      | 4 (2, 8)      | Z = -0.430 | 0.667 <sup>c</sup> |
| Rhinorrhea             | 6 (2, 9)           | 6 (3, 9)      | 6 (2, 9)      | Z = -0.853 | 0.394 <sup>c</sup> |
| Nasal pruritis         | 5 (2, 9)           | 6 (2, 9)      | 5 (2, 9)      | Z = -1.623 | 0.105 <sup>c</sup> |
| RQLQ score             | 68.40 ± 8.48       | 68.50 ± 8.21  | 68.45 ± 8.30  | t = -.053  | 0.958 <sup>a</sup> |
| Objective indications  |                    |               |               |            |                    |
| TNRV (L/20/s)          | 3.56 ± 1.00        | 3.69 ± 0.87   | 3.62 ± 0.94   | t = -0.578 | 0.565 <sup>a</sup> |
| TNV (cm <sup>3</sup> ) | 16.47 ± 2.60       | 16.07 ± 2.56  | 16.27 ± 2.57  | t = 0.675  | 0.502 <sup>a</sup> |
| TNR(KPa/L/s)           | 0.37 ± 0.11        | 0.36 ± 0.05   | 0.36 ± 0.09   | t = 0.681  | 0.499 <sup>a</sup> |

The values in the table are presented as mean ± SD, or median (IQR), or percentage

a, Independent Samples t-test; b, Fisher Exact Test; c, Mann-Whitney U Test

Abbreviation: TNSS, Total Nasal Symptom Score; VAS, Visual Analog Scale; RQLQ, Rhino-conjunctivitis Quality of Life Questionnaire; TNRV, Total Nasal Respiratory Volume; TNV, Total Nasal Volume; TNR, Total Nasal Resistance; IQR, Interquartile Range

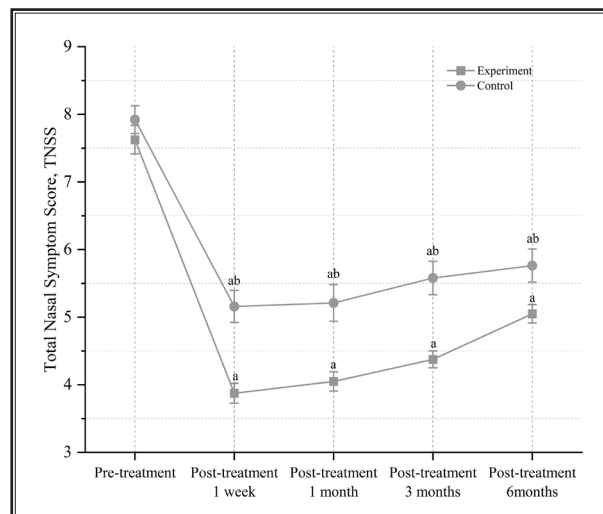
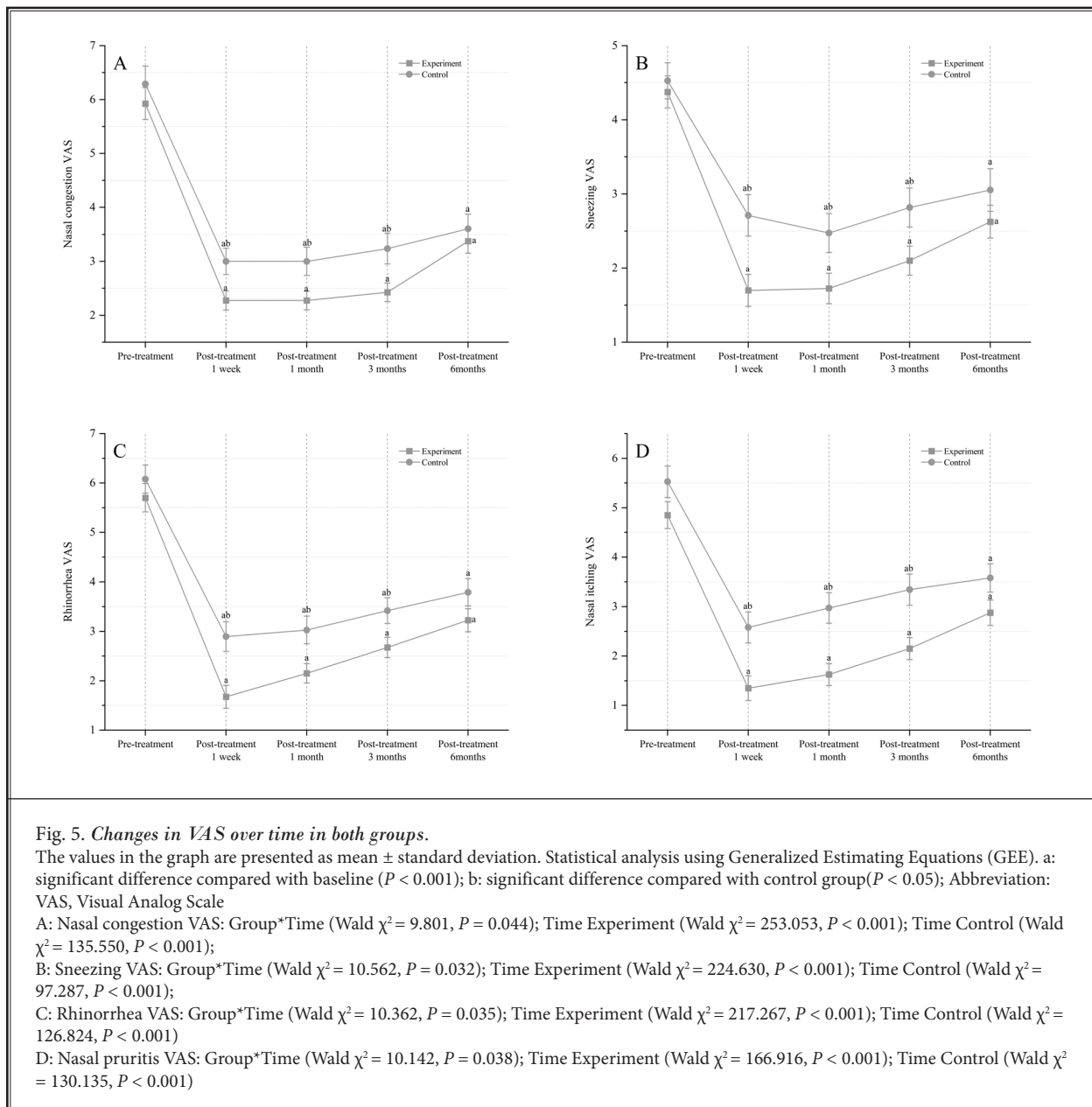


Fig. 4. Changes in TNSS over time in both groups.

The values in the graph are presented as mean ± SD. Statistical analysis using Generalized Estimating Equations (GEE). Group\*Time (Wald  $\chi^2=18.945$ ,  $P = 0.001$ ); Time Experiment (Wald  $\chi^2= 318.980$ ,  $P < 0.001$ ); Time Control (Wald  $\chi^2= 166.001$ ,  $P < 0.001$ ); a: significant difference compared with baseline ( $P < 0.001$ ); b: significant difference compared with control group ( $P < 0.05$ )



numbness of the mouth and tongue. The incidence of this side effect did not differ significantly between the experimental and control groups ( $P > 0.05$ ). There were no complications reported, including punctured oral cavity, infection at the puncture site, nasal bleeding, or drug allergy, in either group (Table 4).

## DISCUSSION

Our study explored the validity and science of ultrasound-guided SPGB for treating AR and assessed

the therapeutic effect of using dexamethasone in SPGB. SPGB is effective in treating AR regardless of dexamethasone administration. Incorporating dexamethasone into the nerve block formulation enhances short-term therapeutic outcomes, but at 6 months posttreatment, although the symptoms are relieved compared to pretreatment, there is no statistically significant difference in the results.

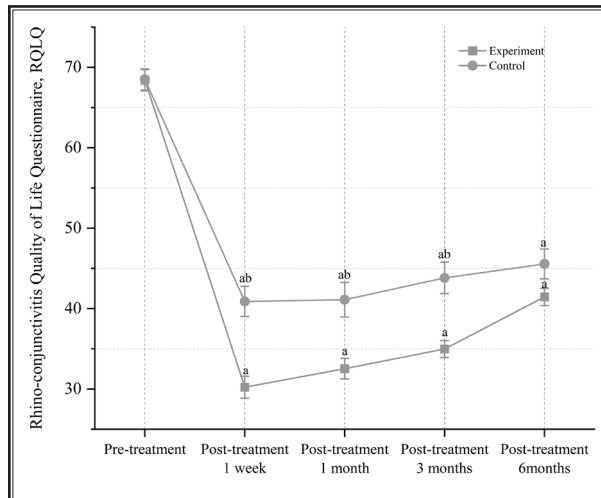
Consistent with prior research, our study confirms that an SPGB effectively treats AR and alleviates symp-

toms (15,29). The sympathetic and parasympathetic nerves in the sphenopalatine ganglion regulate each other (30). AR is mainly caused by autonomic nervous system dysfunction, especially parasympathetic hyperactivity (31). The autonomic nervous system controls nasal symptoms by regulating airway patency: the sympathetic nervous system contracts nasal vessels to reduce resistance, while the parasympathetic nervous system stimulates mucus secretion (31).

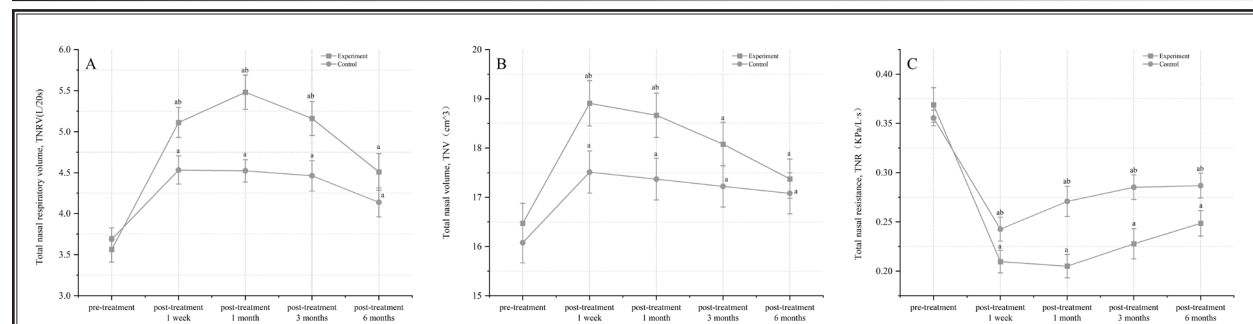
An SPGB activates the nasal vasomotor center in the hypothalamus, inhibiting parasympathetic nerve tension and reducing histamine release, nasal secretions, and pathological vasodilation, thus alleviating nasal mucosa stimulation (32). This significantly improves symptoms such as nasal congestion, sneezing, rhinorrhea, nasal pruritis, and improves quality of life. In our study, significant improvements at all endpoints were noted in both groups at all follow-up time points compared to baseline ( $P < 0.001$ ). Therefore, for patients with AR who have been unresponsive to long-term drug therapy, an SPGB can be considered as an alternative treatment.

Historically, an SPGB for AR was often combined with glucocorticoids and local anesthetics (15). Our study shows that the experimental group had a better short-term outcome than the control group. Dexamethasone is a highly selective and potent glucocorticoid that can be used as an adjunctive drug for nerve blockade (33). It can prolong the action of local anesthetics by blocking the pain impulses of myelinated C

fibers, thereby improving the pathological state of the nerve (33). Dexamethasone may offer neuroprotective benefits by reducing oxidative stress, inhibiting apoptosis, and modulating neurotransmitter release and neuronal excitability (34), thus regulating the balance of autonomic nerve function in the trigeminal ganglion



**Fig. 6. Changes in RQLQ scores over time in both groups.** The values in the graph are presented as mean  $\pm$  SD. Statistical analysis using Generalized Estimating Equations (GEE). Group\*Time (Wald  $\chi^2 = 33.609$ ,  $P < 0.001$ ); Time Experiment (Wald  $\chi^2 = 563.535$ ,  $P < 0.001$ ); Time Control (Wald  $\chi^2 = 244.036$ ,  $P < 0.001$ ); a: significant difference compared with baseline ( $P < 0.001$ ); b: significant difference compared with control group ( $P < 0.05$ )



**Fig. 7. Changes in TNRV, TNV, and TNR over time in both groups.**

The values in the graph are presented as mean  $\pm$  SD. Statistical analysis using Generalized Estimating Equations (GEE). a: significant difference compared with baseline ( $P < 0.001$ ); b: significant difference compared with control group ( $P < 0.05$ );

A: Total Nasal Respiratory Volume: Group\*Time (Wald  $\chi^2 = 24.691$ ,  $P < 0.001$ ); Time Experiment (Wald  $\chi^2 = 156268.135$ ,  $P < 0.001$ ); Time Control (Wald  $\chi^2 = 46.890$ ,  $P < 0.001$ );

B: Total Nasal Volume: Group\*Time (Wald  $\chi^2 = 52.758$ ,  $P < 0.001$ ); Time Experiment (Wald  $\chi^2 = 199.955$ ,  $P < 0.001$ ); Time Control (Wald  $\chi^2 = 94.813$ ,  $P < 0.001$ );

C: Total Nasal Resistance: Group\*Time (Wald  $\chi^2 = 12.106$ ,  $P = 0.017$ ); Time Experiment (Wald  $\chi^2 = 181.830$ ,  $P < 0.001$ ); Time Control (Wald  $\chi^2 = 142.000$ ,  $P < 0.001$ )

Table 2. Total Nasal Symptom Score effective rate.

|           | Experimental Group (n = 40) |             |        |                  | Control Group (n = 38) |             |        |                  | OR    | $\chi^2$ | P Value |
|-----------|-----------------------------|-------------|--------|------------------|------------------------|-------------|--------|------------------|-------|----------|---------|
|           | Effective                   | Ineffective | %      | 95% CI           | Effective              | Ineffective | %      | 95% CI           |       |          |         |
| One week  | 35                          | 5           | 87.50% | (0.773 to 0.976) | 22                     | 16          | 57.89% | (0.422 to 0.736) | 5.091 | 8.681    | 0.003   |
| One month | 34                          | 6           | 85.00% | (0.737 to 0.963) | 24                     | 14          | 63.16% | (0.479 to 0.785) | 3.306 | 4.876    | 0.027   |
| 3 months  | 31                          | 9           | 77.50% | (0.647 to 0.903) | 21                     | 17          | 55.26% | (0.394 to 0.711) | 2.788 | 4.336    | 0.037   |
| 6 months  | 25                          | 15          | 62.50% | (0.475 to 0.775) | 19                     | 19          | 50.00% | (0.341 to 0.659) | 1.667 | 1.238    | 0.266   |

A reduction of Total Nasal Symptom Score by  $\geq 30\%$  is considered effective treatment. The percentages in this table represent effective number of patients/total number of patients.  $\chi^2$  Chi-square test. The 95% confidence interval (95% CI) is calculated using the normal approximation method. Bold data indicates  $P < 0.05$ . OR: Odds ratio.

Table 3. Outcome differences between both groups at pre-treatment and at 4 follow-up time points post-treatment according to the general estimating equation.

| INDICATORS              | Experimental Group |                                         | Control Group |                                         | Difference between groups (95% CI) | P Value |
|-------------------------|--------------------|-----------------------------------------|---------------|-----------------------------------------|------------------------------------|---------|
|                         | (n = 40)           |                                         | (n = 38)      |                                         |                                    |         |
|                         | Mean ± SD          | Mean change ± SD compared with baseline | Mean ± SD     | Mean change ± SD compared with baseline |                                    |         |
| TNSS                    |                    |                                         |               |                                         |                                    |         |
| Pretreatment            | 7.63 ± 0.211       | -                                       | 7.92 ± 0.205  | -                                       | 0.296 (-0.281 to 0.873)            | 0.315   |
| Posttreatment one week  | 3.88 ± 0.147       | -3.750 ± 0.220                          | 5.16 ± 0.237  | -2.763 ± 0.218                          | 1.283 (0.737 to 1.829)             | 0.000   |
| Posttreatment one month | 4.05 ± 0.141       | -3.575 ± 0.215                          | 5.21 ± 0.271  | -2.711 ± 0.241                          | 1.161 (0.561 to 1.760)             | 0.000   |
| Posttreatment 3 months  | 4.38 ± 0.126       | -3.250 ± 0.226                          | 5.58 ± 0.249  | -2.342 ± 0.236                          | 1.204 (0.658 to 1.750)             | 0.000   |
| Posttreatment 6 months  | 5.05 ± 0.137       | -2.575 ± 0.200                          | 5.76 ± 0.245  | -2.158 ± 0.225                          | 0.713 (0.163 to 1.264)             | 0.011   |
| Nasal congestion VAS    |                    |                                         |               |                                         |                                    |         |
| Pretreatment            | 5.925 ± 0.297      | -                                       | 6.289 ± 0.333 | -                                       | 0.364 (-0.509 to 1.238)            | 0.414   |
| Posttreatment one week  | 2.275 ± 0.177      | -3.650 ± 0.275                          | 3.000 ± 0.244 | -3.289 ± 0.304                          | 0.725 (0.134 to 1.316)             | 0.016   |
| Posttreatment one month | 2.275 ± 0.173      | -3.650 ± 0.261                          | 3.000 ± 0.263 | -3.289 ± 0.313                          | 0.725 (0.108 to 1.342)             | 0.021   |
| Posttreatment 3 months  | 2.425 ± 0.173      | -3.500 ± 0.296                          | 3.237 ± 0.284 | -3.053 ± 0.335                          | 0.812 (0.159 to 1.464)             | 0.015   |
| Posttreatment 6 months  | 3.375 ± 0.223      | -2.550 ± 0.300                          | 3.605 ± 0.272 | -2.648 ± 0.307                          | 0.230 (-0.459 to 0.920)            | 0.513   |
| Sneezing VAS            |                    |                                         |               |                                         |                                    |         |
| Pretreatment            | 4.38 ± 0.217       | -                                       | 4.53 ± 0.243  | -                                       | 0.151 (-0.488 to 0.790)            | 0.643   |
| Posttreatment one week  | 1.70 ± 0.216       | -2.675 ± 0.222                          | 2.71 ± 0.278  | -1.816 ± 0.226                          | 1.011 (0.321 to 1.701)             | 0.004   |
| Posttreatment one month | 1.73 ± 0.206       | -2.650 ± 0.182                          | 2.47 ± 0.262  | -2.053 ± 0.223                          | 0.749 (0.095 to 1.403)             | 0.025   |
| Posttreatment 3 months  | 2.10 ± 0.196       | -2.675 ± 0.187                          | 2.82 ± 0.263  | -1.711 ± 0.189                          | 0.716 (0.073 to 1.359)             | 0.029   |
| Posttreatment 6 months  | 2.65 ± 0.220       | -1.750 ± 0.202                          | 3.05 ± 0.288  | -1.474 ± 0.202                          | 0.428 (-0.283 to 1.138)            | 0.238   |
| Rhinorrhea VAS          |                    |                                         |               |                                         |                                    |         |
| Pretreatment            | 5.70 ± 0.288       | -                                       | 6.08 ± 0.284  | -                                       | 0.379 (-0.414 to 1.172)            | 0.349   |
| Posttreatment one week  | 1.67 ± 0.233       | -4.025 ± 0.321                          | 2.89 ± 0.302  | -3.181 ± 0.293                          | 1.220 (0.472 to 1.967)             | 0.001   |
| Posttreatment one month | 2.15 ± 0.195       | -3.550 ± 0.281                          | 3.03 ± 0.280  | -3.053 ± 0.293                          | 0.876 (0.208 to 1.545)             | 0.010   |
| Posttreatment 3 months  | 2.68 ± 0.204       | -3.025 ± 0.290                          | 3.42 ± 0.260  | -2.658 ± 0.287                          | 0.746 (0.099 to 1.393)             | 0.024   |
| Posttreatment 6 months  | 3.22 ± 0.233       | -2.475 ± 0.267                          | 3.22 ± 0.233  | -2.289 ± 0.266                          | 0.564 (-0.140 to 1.269)            | 0.117   |
| Nasal itching VAS       |                    |                                         |               |                                         |                                    |         |
| Pretreatment            | 4.85 ± 0.273       | -                                       | 5.53 ± 0.32   | -                                       | 0.676 (-0.147 to 1.50)             | 0.108   |

Table 3 (cont.). Outcome differences between both groups at pre-treatment and at 4 follow-up time points post-treatment according to the general estimating equation.

| INDICATORS              | Experimental Group |                                         | Control Group  |                                         | Difference between groups (95% CI) | P Value |
|-------------------------|--------------------|-----------------------------------------|----------------|-----------------------------------------|------------------------------------|---------|
|                         | (n = 40)           |                                         | (n = 38)       |                                         |                                    |         |
|                         | Mean ± SD          | Mean change ± SD compared with baseline | Mean ± SD      | Mean change ± SD compared with baseline |                                    |         |
| Posttreatment one week  | 1.35 ± 0.251       | -3.500 ± ±0.292                         | 2.58 ± 0.315   | -2.947 ± 0.309                          | 1.229 (0.439 to 2.019)             | 0.002   |
| Posttreatment one month | 1.63 ± 0.223       | -3.225 ± 0.261                          | 2.97 ± 0.310   | -2.553 ± 0.315                          | 1.349 (0.600 to 2.097)             | 0.000   |
| Posttreatment 3 months  | 2.15 ± 0.222       | -2.700 ± 0.253                          | 3.34 ± 0.314   | -2.184 ± 0.302                          | 1.192 (0.438 to 1.947)             | 0.002   |
| Posttreatment 6 months  | 2.88 ± 0.255       | -1.975 ± 0.241                          | 3.58 ± 0.285   | -1.947 ± 0.266                          | 0.704 (-0.046 to 1.454)            | 0.066   |
| RQLQ score              |                    |                                         |                |                                         |                                    |         |
| Pretreatment            | 68.400 ± 1.324     | -                                       | 68.500 ± 1.315 | -                                       | 0.100 (-3.557 to 3.757)            | 0.957   |
| Posttreatment one week  | 30.225 ± 1.368     | -38.175 ± 1.670                         | 40.895 ± 1.873 | -27.605 ± 1.769                         | 10.670 (6.124 to 15.215)           | 0.000   |
| Posttreatment one month | 32.525 ± 1.274     | -35.875 ± 1.583                         | 41.105 ± 2.152 | -27.385 ± 2.045                         | 8.580 (3.679 to 13.482)            | 0.001   |
| Posttreatment 3 months  | 34.975 ± 1.063     | -33.425 ± 1.567                         | 43.816 ± 1.958 | -24.684 ± 1.926                         | 8.841 (4.474 to 13.208)            | 0.000   |
| Posttreatment 6 months  | 41.450 ± 1.071     | -26.950 ± 1.445                         | 45.553 ± 1.858 | -22.947 ± 1.800                         | 4.103 (-0.101 to 8.306)            | 0.056   |
| TNRV                    |                    |                                         |                |                                         |                                    |         |
| Pretreatment            | 3.56 ± 0.16        | -                                       | 3.69 ± 0.14    | -                                       | 0.12 (-0.29 to 0.53)               | 0.557   |
| Posttreatment one week  | 5.11 ± 0.18        | 1.55 ± 0.10                             | 4.53 ± 0.17    | 0.85 ± 0.14                             | -0.58 (-1.07 to -0.09)             | 0.020   |
| Posttreatment one month | 5.48 ± 0.21        | 1.92 ± 0.24                             | 4.52 ± 0.14    | 0.83 ± 0.23                             | -0.96 (-1.45 to -0.47)             | 0.000   |
| Posttreatment 3 months  | 5.16 ± 0.21        | 1.60 ± 0.24                             | 4.46 ± 0.19    | 0.77 ± 0.25                             | -0.70 (-1.25 to -0.15)             | 0.012   |
| Posttreatment 6 months  | 4.51 ± 0.22        | 0.95 ± 0.26                             | 4.14 ± 0.18    | 0.45 ± 0.21                             | -0.37 (-0.93 to 0.18)              | 0.190   |
| TNV                     |                    |                                         |                |                                         |                                    |         |
| Pretreatment            | 16.47 ± 0.41       | -                                       | 16.08 ± 0.41   | -                                       | -0.40 (-1.53 to 0.74)              | 0.494   |
| Posttreatment one week  | 18.91 ± 0.46       | 2.44 ± 0.18                             | 17.51 ± 0.43   | 1.44 ± 0.15                             | -1.40 (-2.63 to -0.17)             | 0.026   |
| Posttreatment one month | 18.67 ± 0.45       | 2.20 ± 0.16                             | 17.37 ± 0.43   | 1.29 ± 0.13                             | -1.30 (-2.51 to -0.08)             | 0.036   |
| Posttreatment 3 months  | 18.08 ± 0.44       | 1.61 ± 0.15                             | 17.22 ± 0.42   | 1.15 ± 0.12                             | -0.86 (-2.05 to 0.34)              | 0.160   |
| Posttreatment 6 months  | 17.38 ± 0.40       | 0.91 ± 0.12                             | 17.08 ± 0.42   | 1.00 ± 0.10                             | -0.29 (-1.43 to 0.84)              | 0.611   |
| TNR                     |                    |                                         |                |                                         |                                    |         |
| Pretreatment            | 0.369 ± 0.017      | -                                       | 0.356 ± 0.008  | -                                       | -0.013 (-0.051 to 0.024)           | 0.490   |
| Posttreatment one week  | 0.210 ± 0.011      | -0.159 ± 0.012                          | 0.243 ± 0.012  | -0.113 ± 0.011                          | 0.033 (0.000 to 0.066)             | 0.047   |
| Posttreatment one month | 0.205 ± 0.012      | -0.164 ± 0.020                          | 0.271 ± 0.015  | -0.085 ± 0.018                          | 0.066 (0.028 to 0.104)             | 0.001   |
| Posttreatment3 months   | 0.228 ± 0.015      | -0.141 ± 0.025                          | 0.285 ± 0.012  | -0.070 ± 0.016                          | 0.058 (0.019 to 0.096)             | 0.004   |
| Posttreatment6 months   | 0.249 ± 0.013      | -0.120 ± 0.020                          | 0.287 ± 0.013  | -0.069 ± 0.015                          | 0.038 (0.003 to 0.074)             | 0.034   |

The values in the table are presented as mean  $\pm$  SD. Statistical analysis using Generalized Estimating Equations (GEE). Bold data indicates  $P < 0.05$ . Abbreviation: TNSS, Total Nasal Symptom Score; VAS, Visual Analog Scale; RQLQ, Rhino-conjunctivitis Quality of Life Questionnaire; TNRV, Total Nasal Respiratory Volume; TNV, Total Nasal Volume; TNR, Total Nasal Resistance; IQR, Interquartile Range

(35). At the same time, glucocorticoids are the first-line treatment drugs for AR, and by being injected into the nasal cavity or its vicinity, they exert anti-inflammatory, anti-allergic, and anti-edema effects, thereby increasing short-term efficacy (36).

Table 4. Comparison of complication rates between groups.

| Complication    | Experimental Group (n = 40) | Control Group (n = 38) | Overall (n = 78) | OR    | P Value |
|-----------------|-----------------------------|------------------------|------------------|-------|---------|
| Facial swelling | 2 (5.0%)                    | 3 (7.9%)               | 5 (6.4%)         | 0.614 | 0.675*  |
| Oral numbness   | 1 (2.5%)                    | 1 (2.6%)               | 2 (2.6%)         | 0.949 | 0.734*  |

\* Statistical analysis using Fisher's Exact Tests; OR: Odds ratio.

Lidocaine is the primary agent in an SPGB, providing neuroprotective and anti-inflammatory effects (37). Repeated injection therapy can regulate the dysfunction of the parasympathetic nervous system, and balance the sympathetic and parasympathetic nervous systems, thereby alleviating symptoms (38). In our trial, the decline in efficacy of the experimental group (Figs. 4–6) was greater than that of the control group over time. For seasonal AR, adding dexamethasone to the nerve blockade during symptomatic periods enhances short-term efficacy. For long-term management, using only local anesthetics or intermittently incorporating small amounts of glucocorticoids can minimize adverse effects.

Our study found that the treatment's effect decreased over time (Figs. 4–6), suggesting that the parasympathetic nerves of patients with AR may be in a hypersensitive state, and that 4-week nerve blockade treatment is not sufficient to improve long-term AR. The literature suggests that increasing the frequency of sphenopalatine ganglion acupuncture—such as daily or bilateral injections every other day—significantly improves nasal symptoms and quality of life, with effects lasting up to 6 months (39). Conversely, weekly unilateral acupuncture treatment may enhance patient compliance and treatment efficacy (40). Currently, there is no consensus on the optimal course of treatment for an SPGB for nasal disease; more research and clinical experience are needed to establish standardized treatment protocols. In our trial, patients received one injection weekly for 4 weeks. Future treatments may consider increasing that frequency based on patient response, or explore bilateral SPGBs to achieve more sustained effects.

Previous studies on SPGB for treating AR have primarily relied on subjective metrics, such as the VAS and TNSS, while lacking objective evaluations of nasal function. Our study incorporated objective nasal assessments, combining quantitative standards with subjective perceptions to provide a more comprehensive evaluation of SPGB efficacy. The objective metrics included TNRV, TNV, and TNR. Furthermore, the objective data on nasal ventilation were almost consistent with the subjective relief of nasal symptoms reported by patients, reinforcing the efficacy of SPGB treatment.

The experimental group demonstrated greater improvements in TNRV, TNV, and TNR compared to the control group. This enhancement may be attributed to the addition of corticosteroids in the experimental group, which, upon absorption by the nasal mucosa, likely augmented anti-allergic, anti-inflammatory, and anti-edematous effects, thereby prolonging the

duration of neural blockade, delaying the regulation of SPGB, and significantly improving nasal ventilation (41).

Additionally, the improvement trends observed in objective indicators closely mirrored those of subjective symptoms, highlighting a strong alignment between subjective perceptions and objective evaluations. This broad consistency enhances the scientific validity and credibility of the findings. The inclusion of objective metrics in our study allows for more accurate measurement of treatment outcomes and reduces bias from relying solely on patient reports. This approach will help optimize future SPGB protocols and support the development of standardized treatment strategies.

The common side effects of an SPGB primarily include ipsilateral paralysis of the orofacial region, as well as risks of bleeding and infection during the injection (42). In our trial, 2 patients experienced oral numbness, likely due to the diffusion of local anesthetics into the maxillary nerve. Both recovered completely within one week post-treatment. This can be avoided by precise injection, lowering the concentration of local anesthetics, and reducing the injection dose. Five patients in the trial reported facial edema, primarily in the early stages, possibly related to the operator's proficiency. All of these patients improved with facial compression and ice application. Notably, the risks of bleeding and infection during and after the procedure were significantly minimized by ultrasound guidance.

Research indicates that nerve blocks offer considerable economic benefits in managing chronic pain and headaches (43,44), although there are few studies specifically addressing AR. The overall cost of long-term medication use for patients with AR, including antihistamines, corticosteroid nasal sprays, and immunotherapy is high (45). However, for patients in our hospital receiving an ultrasound-guided SPGB, medication costs significantly decreased. While the initial cost of an SPGB is higher than conventional drug therapy, with 4 treatments totaling around ¥1,000 (US \$137.00), its therapeutic effects tend to be long-lasting, alleviating symptoms over an extended period and decreasing the frequency of medical visits.

An SPGB not only provides rapid symptom relief and improves a patient's quality of life, but it also reduces absenteeism and productivity loss due to rhinitis. By decreasing reliance on systemic medications, an SPGB demonstrates clear advantages in direct treatment costs and significantly lowers a patient's long-term medical expenses and indirect costs, thereby

enhancing quality of life and work efficiency while also reducing the risk of complications.

### Limitations

Our study has some limitations. AR significantly affects quality of life and may lead to depression and anxiety. We did not measure these. Future studies should incorporate depression and anxiety questionnaires to assess changes in these scores.

For safety reasons, our study used dexamethasone, a water-soluble long-acting corticosteroid, rather than the particulate corticosteroid triamcinolone acetonide, which has limited water solubility. Dexamethasone may be absorbed into the bloodstream, resulting in lower concentrations in the nasal cavity compared to triamcinolone, potentially affecting efficacy.

Although rare, cases of facial edema and oral numbness were reported. To improve puncture accuracy and reduce complications, future studies could employ 3D navigation technology to predict the puncture path, entry point, and depth, thereby exploring safer and more precise methods for SPGB.

### CONCLUSION

SPGB is a safe and effective treatment for AR, alleviating symptoms such as nasal congestion, rhinorrhea, sneezing, and nasal pruritis. This therapeutic approach significantly improves a patient's quality of life and is particularly beneficial for those with refractory AR. The procedure typically involves the use of local anesthetics, and the addition of glucocorticoids can enhance the treatment's short-term efficacy.

### Informed Consent Statement

Informed consent was acquired from all patients involved in the study.

### Data Availability Statement

Owing to patient confidentiality and ethical considerations, the datasets generated and analyzed during this study may be obtained from the corresponding author upon reasonable request.

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