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Application of Allergen Subcutaneous Immunotherapy in Patients with Allergic Rhinitis

Xiaorong Yang, Bingyue Bai, Zhiquan Peng, Na Zhou, Tingting Jiang*

Department of Otolaryngology and Head and Neck Surgery, Shaanxi Provincial People's Hospital, Xi'an 710068, Shaanxi, China

**Author to whom correspondence should be addressed.*

Abstract: *Objective*: To analyze the efficacy of allergen subcutaneous injection immunotherapy in patients with allergic rhinitis. *Methods*: Fifty patients with allergic rhinitis admitted from May 2023 to May 2025 were selected as study subjects and randomly divided into a control group and an observation group, with 25 patients in each group. The control group was treated with budesonide nasal spray, while the observation group received allergen subcutaneous injection immunotherapy in addition to the control treatment. The treatment efficacy, adverse reactions, symptom improvement time, and immune indicators were compared between the two groups. *Results*: The observation group showed a higher disease treatment efficacy than the control group ($p < 0.05$); the incidence of adverse reactions in the observation group was not statistically significant compared to the control group ($p > 0.05$); the observation group had a shorter symptom improvement time for nasal obstruction, rhinorrhea, and sneezing than the control group ($p < 0.05$); before treatment, there was no statistical significance in immune indicators between the two groups ($p > 0.05$); after treatment, $CD3^+$ and $CD4/CD8^+$ in the observation group were higher than those in the control group ($p < 0.05$). *Conclusion*: Allergen subcutaneous injection immunotherapy in patients with allergic rhinitis can improve disease treatment efficacy, alleviate clinical symptoms, and enhance immune function. This therapy is safe and has clinical application value.

Keywords: Allergen subcutaneous immunotherapy; Allergic rhinitis; Adverse reactions; Immune function

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1. Introduction

Allergic rhinitis, also known as allergic rhinitis, is an inflammatory disease of the nasal mucosa with a high incidence rate globally. According to surveys, 500 million people worldwide are plagued by allergic rhinitis, with a prevalence rate of 12–30%. If this disease is not controlled, it can cause damage to olfactory function, with mucosal swelling during nasal inflammation affecting the sense of smell. It is also prone to cause otitis media, pharyngitis, and tonsillitis, and in severe cases, can lead to intraocular infection [1]. There are many treatment methods for this disease, but most can only alleviate symptoms and cannot fundamentally solve the problem. For

example, corticosteroid treatment, commonly including budesonide, can exert antihistamine, anti-inflammatory, and anti-exudative effects. Subcutaneous allergen immunotherapy is a causal therapy that involves regularly and continuously exposing patients to minute amounts of allergens to reduce their sensitivity to allergens and alleviate allergic symptoms [2]. This therapy can not only improve patients' condition but also reduce the amount of medication used, shorten the duration of the disease, and prevent disease progression. Therefore, this study takes patients with allergic rhinitis admitted to our hospital as the research subjects to analyze the effect of subcutaneous allergen immunotherapy.

2. Materials and methods

2.1. General information

Sixty patients with allergic rhinitis admitted from May 2023 to May 2025 were selected as the study subjects. They were divided into a control group and an observation group using a random number method, with 25 patients in each group. Control group: 15 males and 10 females, aged 23–49 years, with an average age of (34.49 ± 2.83) years and a disease duration of 2–7 (4.10 ± 0.83) years; observation group: 13 males and 12 females, aged 22–51 years, with an average age of (34.56 ± 2.72) years and a disease duration of 2–8 (4.25 ± 1.03) years; there was no statistically significant difference in general characteristics between the two groups ($p > 0.05$).

2.1.1. Inclusion criteria

(1) All participants were aged over 18 years old;
(2) They met the clinical diagnostic criteria for allergic rhinitis;
(3) They had no psychiatric disorders.

2.1.2. Exclusion criteria

(1) Pregnant and lactating women;
(2) Patients with arrhythmia;
(3) Allergic to the drugs used in this study.

2.2. Method

(1) Control group

Treated with budesonide nasal spray, spraying each nostril once daily, twice a day.

(2) Observation group

In addition to the therapy in the control group, allergen subcutaneous injection immunotherapy was administered. The treatment was tailored based on the patient's age, allergic reactions, physical condition, and a dose escalation plan to help patients adapt to allergen stimulation. For patients with severe allergic reactions, the initial allergen dose was set low to ensure treatment safety. For patients with mild dust mite allergy, the initial dose was set at 0.1 mL of a low-concentration allergen preparation, while for patients with severe allergy, the initial dose was 0.05 mL. The escalation phase was divided into 3–4 stages, with treatments administered every 2–4 weeks. This approach allowed the body sufficient time to adapt to the allergen and generate an immune response. At each stage, the patient's adaptation status was evaluated based on local/systemic reactions and changes in serum IgG4 levels, and the dose for the next stage was

planned accordingly.

During the injection, medical staff wear sterile gloves and use a 2% chlorhexidine gluconate solution to perform spiral disinfection centered around the puncture point. The lower edge of the deltoid muscle is selected due to its loose subcutaneous tissue and fewer blood vessels and nerves, which can reduce the risk of vascular and nerve damage. After withdrawing the solution, a two-way exhaust method is employed to avoid residual air bubbles. The needle is changed after each 0.1 mL withdrawal, followed by precise injection of the allergen.

The treatment period for both groups of patients is 6 months.

2.3. Observation indicators

(1) Disease treatment effect

Markedly effective, with the patient's clinical symptoms essentially disappearing and no significant reaction to allergen exposure; Effective, with significant improvement in disease symptoms and enhanced antibodies to allergens; Ineffective, failing to achieve the aforementioned results.

(2) Adverse reactions

Gastrointestinal discomfort, drowsiness, and headache.

(3) Symptom improvement time

Statistics on the time taken for patients' nasal congestion, rhinorrhea, and sneezing symptoms to improve.

(4) Immune indicators

Venous blood samples were collected from patients before and after treatment. The blood was centrifuged to separate the serum, and flow cytometry was used to detect $CD3^+$ and $CD4/CD8^+$ ratios.

2.4. Statistical analysis

The study utilized SPSS 27.0 software for statistical analysis of the data, employing the independent sample *t*-test for continuous data; enumeration data were presented as n and %, with the chi-square test applied, and a p-value < 0.05 indicating statistical significance.

3. Result

3.1. Comparison of effective treatment rates between the two groups of patients

The observation group had a higher effective rate in disease treatment compared to the control group ($p < 0.05$), as shown in **Table 1**.

Table 1. Comparison of effective rates of disease treatment between the two groups of patients (n, %)

Group	Number of cases	Marked effective	Effective	Ineffective	Effective rate
Observation group	25	13 (52.00)	12 (48.00)	0 (0.00)	25 (100.00)
Control group	25	10 (40.00)	10 (40.00)	5 (20.00)	20 (80.00)
χ^2					3.877
p					0.047

3.2. Comparison of adverse reactions between the two groups of patients

The incidence of adverse reactions in the observation group was not statistically significant compared to the

control group ($p > 0.05$), as shown in **Table 2**.

Table 2. Comparison of adverse reactions between the two groups of patients (n, %)

Group	Number of cases	Gastrointestinal discomfort	Drowsiness	Headache	Incidence
Observation group	25	3 (12.00)	2 (8.00)	2 (8.00)	7 (28.00)
Control group	25	2 (8.00)	1 (4.00)	1 (4.00)	4 (16.00)
χ^2					1.745
p					0.084

3.3. Comparison of symptom improvement time between the two groups of patients

The observation group exhibited a shorter improvement time for nasal congestion, rhinorrhea, and sneezing compared to the control group ($p < 0.05$), as shown in **Table 3**.

Table 3. Comparison of symptom improvement time between the two groups of patients ($\bar{x} \pm s$, d)

Group	Number of cases	Gastrointestinal discomfort	Drowsiness	Headache	Incidence
Observation group	25	4.83 ± 0.53	6.51 ± 1.03	8.28 ± 0.83	4.83 ± 0.53
Control group	25	6.73 ± 1.04	9.03 ± 1.44	12.54 ± 1.43	6.73 ± 1.04
t		5.143	6.368	4.265	5.143
p		0.001	0.001	0.001	0.001

3.4. Comparison of two groups' immune indicators

Before treatment, there was no statistically significant difference in immune indicators between the two groups ($p > 0.05$). After treatment, the observation group had higher $CD3^+$ and $CD4/CD8^+$ ratios than the control group ($p < 0.05$), as shown in **Table 4**.

Table 4. Comparison of two groups of immune indicators ($\bar{x} \pm s$)

Group	$CD3^+$		$CD4/CD8^+$	
	Before treatment	After treatment	Before treatment	After treatment
Observation group (n = 25)	28.23 ± 2.71	34.39 ± 1.83	34.39 ± 1.83	1.38 ± 0.11
Control group (n = 25)	28.19 ± 2.35	31.58 ± 2.03	31.58 ± 2.03	1.13 ± 0.16
t	0.176	3.243	3.243	5.254
p	0.897	0.002	0.787	0.001

4. Discussion

Allergic rhinitis is an IgE-mediated non-infectious inflammation of the nasal mucosa. Its triggering mechanism involves complex immune processes. In individuals with atopic constitution, upon exposure to allergens, antigen-presenting cells in the body are engulfed and processed, activating T lymphocytes. Th2 cells undergo excessive activation, disrupting the balance between Th1 and Th2 cells, stimulating B cells to produce specific IgE

antibodies, and leading the body into a sensitized state [3]. After entering the body, allergens bind to IgE antibodies on the surface of mast cells and basophils, triggering degranulation reactions in these cells, releasing histamine, leukotrienes, and various inflammatory mediators from the prostate. These mediators act on nerve endings, blood vessels, and glands, inducing rhinitis, nasal itching, and nasal congestion.

Budesonide nasal spray is a corticosteroid that can alleviate symptoms such as nasal congestion and rhinorrhea caused by allergic rhinitis and sinusitis. It inhibits immune cells and reduces the release of inflammatory factors, achieving anti-inflammatory and anti-allergic effects, and alleviating nasal mucosal swelling and secretions [4]. For example, the drug acts on the nasal mucosa, reducing the accumulation of inflammatory cells and inhibiting the release of histamine inflammatory mediators, thereby improving nasal secretions. For patients with allergic rhinitis, it can not only reduce the sensitivity of the nose to allergens, alleviate symptoms such as sneezing and nasal itching, but also prevent seasonal rhinitis through long-term regular use. Budesonide has low systemic absorption and mild side effects. Long-term and large-scale use may cause nasal dryness and bleeding, so the dosage should be adjusted according to medical advice. Patients in the control group who were treated with this drug achieved good results [5].

Subcutaneous immunotherapy gradually increases and decreases the amount of allergen, stimulating and regulating T cell activation, inhibiting Th2 immune response, and achieving long-term immune tolerance. The allergen is injected into the patient's body in a small dose and gradually increasing pattern. Dendritic cells ingest the allergen, process it, and then transfer it to T cells. After activating Treg cells, these cells can inhibit Th2 cells from secreting IL-4 and IL-5, reducing inflammatory reactions. Treg cells can regulate other immune activities, reduce the release of inflammatory mediators, modulate IgE-mediated reactions, and enable the body to develop immune tolerance to allergens [6].

From the results, it can be seen that after treatment, the observation group patients exhibited a higher disease treatment efficacy rate, with a more pronounced therapeutic effect compared to the control group, and their symptom improvement time was shorter than that of the control group. After subcutaneous injection of allergens, the body's immune balance undergoes changes, stimulating the activation of Treg cells and regulating immune responses. This can reduce inflammatory cytokines, inhibit the activity of macrophages and dendritic cells, alleviate the release of inflammatory factors, and suppress the activity of macrophages and dendritic cells, thereby reducing inflammatory reactions [7]. TGF-β promotes the synthesis of extracellular matrix, regulates immune responses, and promotes tissue repair, improving the inflammatory microenvironment, thereby alleviating various clinical symptoms of allergic rhinitis.

The observation group patients exhibited superior improvement in immune function compared to the control group, with no significant difference in safety between the two groups. During allergen subcutaneous injection, common adverse reactions include local and systemic adverse effects such as itching, wheal and flare, gastrointestinal reactions, headache, and somnolence. To prevent adverse reactions, relevant intervention measures can be taken before treatment, such as premedication with antihistamines, including loratadine and cetirizine, which can reduce the body's sensitivity to allergens and have a significant effect on preventing adverse reactions [8]. If mild local adverse reactions occur, they can usually resolve spontaneously. If systemic adverse reactions such as dyspnea, wheezing, and angioedema occur, emergency procedures for anaphylaxis should be followed. The goal of allergen immunotherapy is to induce the body to develop allergen-specific tolerance, preventing abnormal immune responses. This tolerant state is maintained long after treatment has ceased. The establishment of immune tolerance is a result of multi-faceted synergistic effects, such as low-dose continuous allergen stimulation, inducing Treg cell

activation, and establishing central immune tolerance. An increase in allergen-specific IgG4 can exert a blocking effect, reducing allergen stimulation of immune cells, consolidating the immune state, and enhancing human immunity and resistance. Studies have indicated that allergen subcutaneous injection immunotherapy can improve patients' allergic reactions over the long term, maintaining immune tolerance even after drug withdrawal [9]. The mechanism is related to the long-term survival and functional stability of Treg cells.

However, during the implementation of this therapy, accurate assessment and detection of allergens are crucial. Clinically, skin tests are commonly used, which are simple to perform. A small amount of highly purified allergen solution is dripped onto the skin of the patient's forearm, and a special prick needle is used to penetrate the surface layer of the skin, allowing the allergen to come into contact with the mast cells in the skin and providing a preliminary assessment of the patient's allergic response [10]. Based on the allergens identified through the test, an injection-related immunization plan is determined to help patients effectively control allergic rhinitis. A comprehensive emergency plan is also formulated to ensure timely treatment in case of adverse reactions. Overall, this study has achieved the expected results, but there are also shortcomings, such as a small sample size and insufficient representativeness. In the future, it is necessary to expand the sample size, including patients from different regions, ethnic groups, and living environments, to better understand the applicability of this therapy in different populations.

5. Conclusion

In summary, allergen subcutaneous immunotherapy for patients with allergic rhinitis can effectively improve their condition, enhance immune function, and increase treatment efficacy. It is also highly safe and has clinical application value.

Disclosure statement

The authors declare no conflict of interest.

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