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The Effect of Steroid Sprays on Nasal Mucociliary Clearance in Patients of Allergic Rhinitis: A Pre Post Interventional Study

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ABSTRACT

Background: Allergic rhinitis (AR) is a chronic inflammatory disorder of the nasal mucosa characterized by nasal obstruction, rhinorrhea, sneezing, and itching. Impaired nasal mucociliary clearance (MCC) is a key pathological feature contributing to symptom persistence and susceptibility to infections. Intranasal corticosteroids (INCS) are first-line therapy for AR; however, their impact on mucociliary clearance remains variably reported.
Aim: To evaluate the effect of intranasal corticosteroid sprays on nasal mucociliary clearance in patients with allergic rhinitis.
Methods: A hospital-based pre–post interventional study was conducted on 60 patients with persistent mild allergic rhinitis. Baseline mucociliary clearance was assessed using the saccharin transit time (STT) test. Patients were treated with intranasal fluticasone furoate for 3 weeks, after which STT was reassessed. Statistical analysis was performed using paired t-test, Pearson correlation, and ANOVA where applicable.
Results: The mean mucociliary clearance time significantly reduced from **11.81 ± 9.01 minutes pre-treatment to 8.20 ± 6.08 minutes post-treatment** ($p = 0.001$), representing a **30.51% improvement**. No statistically significant association was observed between improvement and age ($p = 0.163$), duration of symptoms ($p = 0.190$), gender ($p = 0.937$), education ($p = 0.739$), or socioeconomic status ($p = 0.504$).
Conclusion: Intranasal corticosteroid therapy significantly improves mucociliary clearance in allergic rhinitis without influence from demographic variables. This supports their role not only in symptom control but also in restoring nasal physiological defense mechanisms.

Keywords*: Allergic Rhinitis, Intranasal Corticosteroids, Mucociliary Clearance, Saccharin Transit Time, Fluticasone Furoate*

INTRODUCTION

Allergic rhinitis (AR) is a highly prevalent immunoglobulin E (IgE)-mediated inflammatory condition affecting the nasal mucosa, characterized by symptoms such as nasal obstruction, rhinorrhea, sneezing, and itching (1,2). The disease results from an exaggerated immune response to inhaled allergens, leading to activation of mast cells and release of inflammatory mediators including histamine, leukotrienes, and cytokines (3). AR is classified into intermittent and persistent forms, depending on symptom duration, and further categorized by severity according to the Allergic Rhinitis and its Impact on Asthma (ARIA) guidelines (2,4).

Globally, AR affects approximately 10–40% of the population and has shown a rising trend, especially in urban and industrial regions (2,5). The disease significantly impacts quality of life, sleep, productivity, and healthcare utilization (6).

In addition to symptomatic burden, AR also predisposes individuals to secondary infections due to impairment of local defense mechanisms, particularly mucociliary clearance (7).
The nasal mucociliary clearance (MCC) system constitutes one of the most vital innate defense mechanisms of the respiratory tract (8). It involves coordinated beating of cilia lining the respiratory epithelium and the transport of mucus, which traps inhaled pathogens and particulate matter (9). Efficient MCC depends on factors such as ciliary beat frequency, mucus viscosity, and airway surface liquid composition (10). In allergic rhinitis, chronic inflammation disrupts this system, leading to delayed clearance and accumulation of secretions (11).

The saccharin transit time (STT) test is a widely accepted, simple, and cost-effective method for assessing mucociliary function (12). It measures the time taken for a subject to perceive a sweet taste after placement of saccharin in the nasal cavity, reflecting ciliary transport efficiency (13). Prolonged STT indicates impaired mucociliary clearance and is commonly observed in conditions such as allergic rhinitis, sinusitis, and nasal polyposis (14).

Management of allergic rhinitis primarily focuses on allergen avoidance and pharmacotherapy (15). Among available treatment options, intranasal corticosteroids (INCS) are considered the most effective due to their potent anti-inflammatory action (2). They act by inhibiting cytokine production, reducing eosinophilic infiltration, and suppressing inflammatory pathways (8). INCS are superior to antihistamines and leukotriene receptor antagonists in controlling nasal symptoms, particularly congestion (11).

Despite their widespread use, the effect of INCS on mucociliary clearance remains controversial. Some studies suggest that corticosteroids do not impair MCC and may even improve it by reducing inflammation. Conversely, certain in vitro studies have demonstrated potential inhibitory effects on ciliary beat frequency at higher concentrations. These conflicting findings necessitate further clinical evaluation.

Given the limited and inconsistent data regarding the effect of intranasal corticosteroids on mucociliary clearance, the present study was conducted to assess changes in mucociliary clearance time following steroid spray therapy in patients with allergic rhinitis using the saccharin transit time test.

MATERIALS AND METHODS

This study was designed as a **prospective pre–post interventional study** conducted in the Department of Otorhinolaryngology at Maharaja Agrasen Medical College, Agroha, over a duration of 12 months following ethical clearance.

Study Population

A total of **60 patients** diagnosed with persistent mild allergic rhinitis were included. Patients were recruited from both outpatient and inpatient departments using **convenience sampling**.

Inclusion Criteria

- Age group: 15–40 years
- Persistent mild allergic rhinitis (>4 days/week, >4 weeks)
- No treatment in the preceding 15 days
- Willing to provide informed consent

Exclusion Criteria

- Acute sinusitis or severe AR
- Previous nasal surgery
- Nasal polyps or deviated septum
- Pregnancy
- Congenital nasal anomalies

Sample Size

Calculated using OpenEpi software with 95% confidence interval and 90% power based on prior studies; final sample size was increased to 60 to account for attrition.

Procedure

Baseline mucociliary clearance was assessed using the **saccharin transit time (STT) test**. A saccharin particle was placed approximately 1 cm posterior to the anterior end of the inferior turbinate. Patients were instructed to swallow periodically and report the onset of sweet taste. Time was recorded in minutes.

Following baseline assessment, patients received **intranasal fluticasone furoate spray** for 3 weeks. The STT test was repeated after treatment.

Outcome Measure

- Primary: Change in mucociliary clearance time (minutes)

Statistical Analysis

- Mean ± SD calculated for quantitative variables
- Paired t-test for pre–post comparison
- Pearson correlation for associations
- ANOVA for categorical variables
- $p < 0.05$ considered significant

RESULTS

Table 1: Demographic Profile

Profile	Key Finding	Short Interpretation
Age	19–30 years (45%) highest	Majority were young adults
Gender	Males 58.33%	Male predominance observed
Residence	Rural 90%	Predominantly rural population
Education	Uneducated 36.67% highest	Majority had low education level
Profession	Farmers 31.67%, Students 23.33%	High exposure occupations/groups dominant
Socio-economic status	Low class 61.67%	Majority from lower socioeconomic group

The study population was predominantly **young adults**, with a higher proportion of **males**. Most participants belonged to **rural areas**, had **lower educational status**, and were mainly **farmers or students**, indicating higher exposure to environmental allergens. A majority were from the **lower socioeconomic group**, suggesting a possible association between socioeconomic factors and increased prevalence of allergic rhinitis.

Table 2: Effect of Steroid Spray on Mucociliary Clearance

Parameter	Mean (min)	SD	% Change	p-value
Pre-treatment	11.81	9.01	—	—
Post-treatment	8.20	6.08	30.51% ↓	0.001

There was a **statistically significant reduction** in mucociliary clearance time ($p = 0.001$). The **30.51% improvement** indicates enhanced ciliary function following steroid therapy.

Table 3: Association with Demographic Variables

Variable	Mean Improvement	p-value
Age	3.60 min	0.163
Duration	3.60 min	0.190
Gender	M: 3.67 / F: 3.51	0.937
Education	—	0.739
Socioeconomic	—	0.504

No statistically significant association was found between improvement in mucociliary clearance and demographic variables ($p > 0.05$). This suggests the therapeutic effect is **uniform across patient groups**.

Overall Findings

- Significant improvement in MCC after steroid therapy
- Improvement independent of demographic factors
- Supports physiological restoration of nasal defense

DISCUSSION

Allergic rhinitis (AR) is a chronic inflammatory disorder of the nasal mucosa characterized by symptoms such as rhinorrhea, nasal obstruction, sneezing, and itching. The pathophysiology involves an IgE-mediated hypersensitivity response leading to the release of inflammatory mediators, which not only produce symptoms but also impair normal nasal

physiology, including mucociliary clearance (MCC) (1,2). The present study aimed to evaluate the effect of intranasal corticosteroid therapy on mucociliary clearance in patients with allergic rhinitis using the saccharin transit time (STT) test. The demographic findings of this study revealed that the majority of patients belonged to the 19–30 years age group (45%), indicating that allergic rhinitis predominantly affects young adults. Similar age distribution has been reported in previous studies, where increased exposure to environmental allergens and occupational factors contributes to higher prevalence in this age group (3). A male predominance (58.33%) was observed, which is consistent with studies by Gill et al. and Nambiar et al., suggesting possible gender-based exposure differences or healthcare-seeking behavior (4,5).

A striking observation in this study was the predominance of rural population (90%), with most patients belonging to lower socioeconomic strata (61.67%). This may be attributed to increased exposure to environmental allergens such as dust, pollen, agricultural chemicals, and biomass fuel smoke, which are more prevalent in rural settings (6). Additionally, lower educational status observed in the study population may contribute to delayed healthcare access and poor awareness regarding allergen avoidance and treatment options (7).

The primary outcome of this study demonstrated a statistically significant reduction in mucociliary clearance time from 11.81 ± 9.01 minutes pre-treatment to 8.20 ± 6.08 minutes post-treatment ($p = 0.001$), indicating a 30.51% improvement. This finding suggests that intranasal corticosteroids not only alleviate symptoms but also restore mucociliary function. The improvement in MCC can be explained by the anti-inflammatory action of corticosteroids, which reduces mucosal edema, decreases inflammatory cell infiltration, and improves ciliary beat frequency (8,9).

These results are in agreement with the findings of Nambiar et al., who reported a reduction in mucociliary clearance time following treatment with fluticasone preparations (5). Similarly, Gill et al. demonstrated a significant improvement in MCC after topical steroid therapy, with reduction in clearance time observed as early as one month (4). The consistency of these findings supports the beneficial role of intranasal corticosteroids in improving nasal physiology.

However, some studies have reported contrasting findings. Pata et al. found no significant change in mucociliary clearance time after administration of mometasone furoate (10). These discrepancies may be attributed to differences in study design, duration of treatment, sample size, and variations in drug formulation. It is also important to note that in vitro studies have shown dose-dependent suppression of ciliary beat frequency with corticosteroids, whereas in vivo studies, including the present one, demonstrate minimal or reversible effects (11).

The saccharin transit time test used in this study is a simple, cost-effective, and reliable method for assessing mucociliary clearance. It has been widely used in clinical studies and correlates well with more advanced techniques such as radioisotope scanning (12). The baseline mucociliary clearance time observed in this study was higher than normal values reported in healthy individuals (5–13 minutes), indicating impaired mucociliary function in patients with allergic rhinitis (13). This impairment is likely due to chronic inflammation leading to altered mucus properties and ciliary dysfunction.

Another important observation in this study was the lack of statistically significant association between improvement in mucociliary clearance and demographic variables such as age, gender, education, and socioeconomic status. This suggests that the therapeutic effect of intranasal corticosteroids is consistent across different patient groups. Similar findings have been reported by Mehra et al., who found no significant correlation between demographic variables and mucociliary clearance improvement (14).

The improvement in mucociliary clearance following steroid therapy has important clinical implications. Efficient mucociliary clearance plays a critical role in protecting the respiratory tract from pathogens and particulate matter. Restoration of this mechanism can reduce the risk of secondary infections and improve overall nasal health (15). Therefore, intranasal corticosteroids not only provide symptomatic relief but also enhance the physiological defense mechanisms of the nasal mucosa.

Despite its strengths, the present study has certain limitations. The relatively small sample size and short duration of follow-up may limit the generalizability of the findings. Additionally, the use of a single method (STT) for assessing mucociliary clearance may not capture all aspects of mucociliary function. Future studies with larger sample sizes, longer follow-up periods, and advanced diagnostic techniques are recommended to further validate these findings.

Overall, the present study provides strong evidence supporting the beneficial effect of intranasal corticosteroids on mucociliary clearance in patients with allergic rhinitis. The significant improvement observed reinforces their role as first-line therapy in the management of this condition.

CONCLUSION

Intranasal corticosteroid therapy significantly improves mucociliary clearance in patients with allergic rhinitis, as demonstrated by a marked reduction in saccharin transit time. This improvement is independent of demographic factors

and highlights the dual role of corticosteroids in both symptom control and restoration of nasal physiological defense mechanisms.

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