

## Short communication

# The reduction of rhinitis symptoms by nasal filters during natural exposure to ragweed and grass pollen

**Background:** Prototype nasal filters were developed to collect inhaled pollen. This study evaluated the efficacy of the filters for prevention of rhinitis symptoms during acute outdoor pollen exposure.

**Methods:** A randomized double-blind design was used. Subjects ( $n = 46$ ) with a history of autumn exacerbation of rhinitis and positive skin test to ragweed, Bermuda and/or Bahia grass wore either active or placebo nasal filters for 2 h in autumn in a park containing these species. Major and Total Symptoms scores were recorded at 0, 30, 60, 90 and 120 min.

**Results:** Subjects wearing active nasal filters had significantly reduced scores, at all time-points compared with placebo group (all  $P < 0.05$ ). Of 14 individual symptoms measured, seven were significantly reduced (number of sneezes, runny nose, itchy nose, sniffles, itchy throat; itchy eyes and watery eyes) and another three showed a trend towards lower severity. The nasal filters also enabled the resolution of existing symptoms. Maximal difference in symptoms was seen immediately after subjects had spent 20 min sitting beside a large patch of ragweed.

**Conclusion:** This is the first clinical trial of a nasal filter. The results suggest it has potential for enhancing rhinitis management during acute allergen exposure.

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Avoidance of allergens is advocated as the first step in management of allergic rhinitis, and as an adjunct to medications (1, 2). It is recognized, however, that avoidance of pollens and fungal spores is difficult to achieve because of their ubiquitous nature (1). Facemasks provide personal protection; however, they are only used by 1% of people (3). While the mainstay of rhinitis management is pharmacotherapy, 74% of people report that medications do not adequately control their symptoms, and 65% report avoiding some medications because of their side-effects (3).

We have previously described nasal filters, worn inside the nose that collect inhaled particles using the principle of impaction (4). They are easy to breathe through, and have a high capture efficiency for particles above 8  $\mu\text{m}$  in diameter (4), which includes all pollens (5). Given the prevalence of allergic rhinitis, the level of dissatisfaction with current medications and lack of acceptance of an effective method to prevent exposure outdoors, we tested a prototype nasal filter to determine if it would reduce symptoms of allergic rhinitis during high natural exposure to pollens.

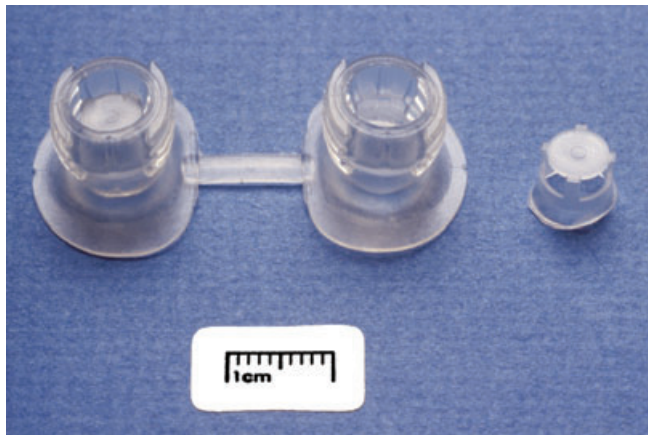
## Material and methods

### Nasal filters

The nasal filter is shown in Fig. 1. The airflow resistance and capture efficiencies for ragweed (*Ambrosia artemisiifolia*), Bermuda grass (*Cynodon dactylon*) and Bahia grass (*Paspalum notatum*) pollen (Greer Laboratories Inc., Lenoir, NC) were measured at flow rates of 4.6, 10.3, 21.7 and 32.5 l/min as previously described (4).

### Allergen challenge study

The study utilized a double-blind placebo-controlled design. The study was approved by the Human Ethics Committee of Northern Rivers Area Health Service, and subjects gave written informed consent. Eligible subjects were over 16 years old, had a history of rhinitis exacerbation in the autumn and were skin prick test-positive to mixed ragweed, Bermuda grass and/or Bahia grass (Table 1). Exclusion criteria were: complete nasal obstruction, recent sinusitis, history of severe asthma exacerbations, or use of nasal steroids/antihistamines/systemic decongestants within the last month. The study location was a semirural park with abundant flowering Bahia and Bermuda grasses and ragweed. Prior to arriving at the park subjects wore disposable dust-masks to reduce the development of baseline symptoms. Subjects were randomly allocated to one of



**Figure 1.** The nasal filter prototype is made up of a soft medical grade silicone and has an inner polypropylene core is coated with an adhesive. The placebo filters were of identical external appearance, but did not have an inner core (inner core has been removed from only one nostril in this picture). To accommodate different sized noses, two sizes of nasal filter were used.

Table 1. Baseline subject characteristics

	Active nasal filter	Placebo nasal filter
<i>n</i>	22	24
Female, <i>n</i> (%)	14 (64%)	15 (68%)
Average age, years (range)	51.1 (32–71)	50.3 (17–75)
Duration of allergic rhinitis, years (range)	26.4 (4–62)	29 (1–55)
Baseline MSC severity score, mean (SD)	339.8 (238.2)	187.3* (182.2)
Baseline TSC severity score, mean (SD)	556.2 (382.4)	309.3* (265.3)
SPT-positive to ragweed,	22 (100)	24 (100)
Bahia or Bermuda grass, <i>n</i> (%)		
SPT-positive to ragweed, <i>n</i> (%)	20 (91)	17 (71)
SPT-positive to Bahia grass, <i>n</i> (%)	11 (50)	18 (75)
SPT-positive to Bermuda grass, <i>n</i> (%)	7 (32)	16 (67)*
SPT-positive to <i>Dermatophagoides pteronyssinus</i> , <i>n</i> (%)	17 (77)	13 (54)

MSC, Major Symptom Complex, range 0–1360 (number of nose blows, number of sneezes, runny nose, sniffles, itchy nose and watery eyes); TSC, Total Symptom Complex, range 0–2448 (MSC symptoms plus itchy eyes, itchy ears, itchy throat, cough and postnasal drip); SPT-positive = skin prick test weal  $\geq 4$  mm<sup>2</sup>. \* =  $P < 0.05$  between active and placebo groups.

eight groups, and each group received either active ( $n = 22$ ) or placebo ( $n = 24$ ) nasal filters (Fig. 1). To eliminate visual unblinding: neither participants nor group supervisors (medical students) had previous experience of the nasal filters; the way the filters worked was not explained to the participants or supervisors; supervisors were blinded to the randomization allocation; within each group all subjects received the same type of filter; there was no contact between groups; and the external appearance of the active and placebo filters, once inserted, was identical.

After baseline assessments, subjects removed the dust-masks and placed the nasal filters into their nostrils. Subjects were asked to breathe through the nose for 2 h, while engaging in only mild activity (sitting, walking, eating) in a central location in the park.

Self-assessed rhinitis symptoms and peak nasal inspiratory flow were recorded at baseline and at 30 min intervals during the challenge. Self-recorded symptoms were combined into two composite variables: Major Symptom Complex (MSC) and Total Symptom Complex (TSC) severity scores (6–8). To ensure that at least moderate levels of ragweed pollen exposure were experienced by all participants, each group sat beside a large patch of ragweed for 20 min, during the period 30–60 min after filter insertion.

### Pollen exposure

Ambient pollen levels were measured using a Burkard 7-day volumetric spore trap, running at 10 l/min, located 3.5 m above the ground at the challenge site. Individual pollen exposures were measured by the number of pollen grains collected on the adhesive core of the active nasal filters. Samples were stained with Calberla's solution (9) and ragweed and grass pollen were counted under a microscope.

### Acceptability of filters

In a questionnaire administered 1 week after the challenge, subjects were asked to score their global satisfaction with the nasal filters.

### Statistical analysis

The primary outcome variables were change in MSC and TSC scores from baseline, using all time-points. Secondary outcome variables were changes from baseline in the individual components of MSC and TSC. Overall differences between groups were examined by repeated measures ANOVA, and *t*-tests were used to analyse differences between treatment groups at each time-point. Differences between groups in the frequency of sensitization were examined by chi-squared test. Statistical significance was defined as  $P < 0.05$ .

## Results

In the test rig, pollen capture for Bahia, Bermuda and ragweed averaged 98% for active and 3.5% for placebo filters, across the range of flow rates. Airflow resistance, measured at 1 cmH<sub>2</sub>O differential pressure, was 4.5 cmH<sub>2</sub>O/L/s for active and 1.6 cmH<sub>2</sub>O/L/s for placebo filters.

Pollen exposure on the challenge day was measured at 102 grains/2 h from the spore trap, and 68 pollen grains/person/2 h from the active filters (geometric mean values).

### Symptoms

Baseline MSC scores, prior to filter insertion, were 339.8 and 187.3 for the active ( $n = 22$ ) and placebo ( $n = 24$ ) filter groups, respectively ( $P = 0.02$ ). Over the 2-h challenge period MSC decreased in the active group and increased in the placebo group compared with baseline (Fig. 2), resulting in highly significant differences between

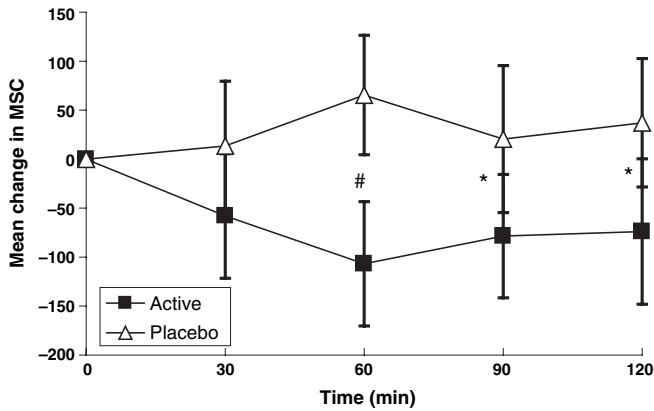


Figure 2. Mean absolute change in MSC scores between active and placebo nasal filter groups. Overall difference between active and placebo  $P = 0.0076$ , repeated measures ANOVA. Error bars are 95% confidence intervals (CIs) for each mean. # $P < 0.001$ , \* $P < 0.05$  ( $t$ -test). MSC = Major Symptom Complex (number of nose blows, number of sneezes, runny nose, sniffles, itchy nose and watery eyes).

the groups (overall,  $P = 0.0076$ ). At 30, 60, 90 and 120 min the net difference in MSC for active compared with placebo filters were  $-25$ ,  $-68$ ,  $-39$  and  $-50\%$  points respectively. The maximum difference was seen at 60 min, immediately after the 20 min period of sitting beside a large patch of ragweed. Similar differences between active and placebo filters were seen in TSC scores (data not shown, overall  $P = 0.023$ ).

For seven of the 14 individual symptoms, there was a significant reduction in severity and for a further three symptoms there was a consistent trend towards lower severity in the active filter group than the placebo group. The strongest effect was seen for the symptoms of sniffles (overall,  $P = 0.004$ ), rhinorrhea (overall,  $P = 0.035$ ) and itchy nose (overall,  $P = 0.034$ ), especially at 60 min (Fig. 3) where highly significant differences were found. During the 2-h challenge period, significant reductions were also observed in number of sneezes, itchy throat, itchy eyes and watery eyes ( $P < 0.05$ ,  $t$ -test). For number of nose blows, nasal blockage and peak nasal inspiratory flow, there was a trend to improvement in the active group but the differences were not significant. The active filters did not appear to influence postnasal drip or cough, while a significant ( $P < 0.05$ ) increase in itchy ears was observed overall and at 90 min.

Acceptability of filters

Ninety-three percent of subjects said they would be prepared to wear the filters again, with most people prepared to use them in private situations such as around the house (88%) or in the garden (81%) compared with visiting friends (46%) or playing golf (33%).

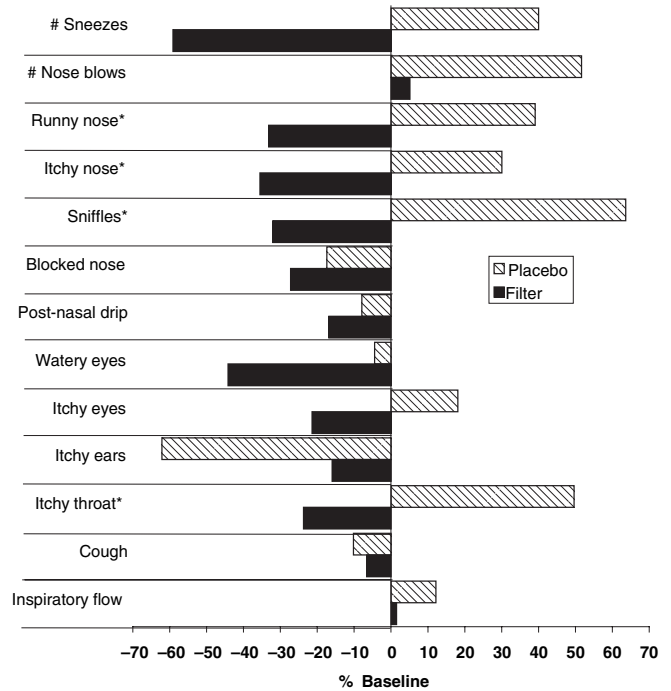


Figure 3. Percentage change from baseline in each symptom score for active and placebo filter groups at 60 min. \* $P < 0.05$  at 60 min ( $t$ -test). Individual symptoms that were significantly reduced by the filters during the 2 h study were: number of sneezes, runny nose, itchy nose, sniffles, itchy throat, itchy eyes and watery eyes.

Discussion

This is the first reported clinical trial of nasal filters for the prevention of symptoms of allergic rhinitis. The nasal filters collect inhaled particles by impaction (4), resulting in high capture efficiency for particles above  $8 \mu\text{m}$  and negligible air-flow resistance (4, 10). Most pollen grains are above  $15 \mu\text{m}$  in diameter and ragweed, Bermuda and Bahia pollens which are 18, 28 and  $34 \mu\text{m}$ , respectively (5) were captured with high efficiency in the nasal filter test rig.

In the clinical trial of natural outdoor pollen exposure, the net difference in MSC scores were the result of decreases in symptoms in the active filter group ( $-18$  to  $-33\%$ ) and increases in symptoms in the placebo filter group ( $+7$  to  $+35\%$ ), with a maximum net difference in MSC of 68% at 60 min. While this study did not compare the efficacy of the filters to rhinitis medications, a survey of the literature indicates that both the magnitude and onset of symptom reduction with active filters compares very favourably with that from medications (6–8, 11). The rapid reduction of pre-existing symptoms in the active filter group may expand the utility of the filters. In studies of rhinitis medications, which have used similar acute challenge experiments, there has been a well-recognized placebo effect (6–8), which was not observed for the

placebo filter group, although the low baseline symptoms may account for this. Of note is the beneficial effect of the nasal filters on ocular symptoms (Fig. 3), which is consistent with the converse observations of ocular symptoms occurring following direct nasal challenge (1).

Although the active nasal filter group had significantly higher baseline symptoms than the placebo group, this did not explain the significant reduction in symptoms in the active group. A *post hoc* analysis of data for individuals with similar mid-range baseline symptoms in both groups ( $n = 10/\text{group}$ ) showed a significant reduction in MSC and TSC for the active filter group ( $-35\%$ ), while symptoms in the placebo group increased by approximately  $28\%$  ( $P < 0.05$ ). The active and placebo groups also differed in the prevalence of sensitization to Bermuda grass (Table 1); however, this was not related to baseline MSC scores ( $P = 0.89$ , *t*-test).

The nasal filters may also have an application for the prevention of exposure to perennial allergens, especially those from house dust mites where the majority of allergen is carried on particles above  $10\ \mu\text{m}$  in diameter

(12). Conventional allergen avoidance strategies such as mattress encasing, when practiced with high allergen load in a normal domestic setting, often appear to fail to reduce allergens to a level where significant improvement in symptoms occur [see meta-analysis (13)]. Additional studies are required to examine the feasibility of using the nasal filters for longer periods, as would be needed for perennial allergens.

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