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Original Research Article

Role of Microplastics in Chronic Rhinosinusitis Without Nasal Polyps

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Abstract: ***Introduction***- Microplastics originating from plastic materials may pose risks to human health. When MPs get into the nasal cavity, they might damage the nasal tissues directly, which may make it easier for them to travel to other organs through nasal penetration. The present study was done to examine the relationship between chronic rhinosinusitis without nasal polyps and microplastics. ***Material and method***s- The present prospective study was conducted at department of otorhinolaryngology , head and neck surgery of Dr DY Patil medical College , hospital and research centre for a study period of one year. A total of 50 patients diagnosed with Chronic Rhinosinusitis without nasal polyps and using nasal lavage treatment with saline (0.9% isotonic NaCl) were included in group A and 50 patients with any allergy related to nasal cavity without nasal polyp were considered in group B. All participants were given the Nasal Obstruction Symptom Evaluation (NOSE) questionnaire in their preferred language in order to gauge subjective nasal obstruction. ***Results***- The mean age of patients in group A was 42.3 ± 10.5 and in group B was 40.1 ± 9.7. number of male patients in group A was 28 and in group B was 30. The NOSE scores were significantly higher (<0.001) in the group A (65.4 ± 12.7) as compared to group B (18.2 ± 8.6), indicating more severe nasal obstruction symptoms compared to controls. In nasal lavage samples, Group A (n=50) had substantially greater levels of microplastic contamination (12.6 ± 4.3) than Group B (n=50) (4.2 ± 2.1). 94% of Group A had microplastics, while only 60% of Group B did. In Group A, the average number of particles per sample was almost three times more. Fibers were the most commonly seen microplastic forms, and indicates that the predominant polymer types were polyethylene (PE), polystyrene (PS), and polypropylene (PP), which were present in both groups although in varying amounts. ***Conclusion*** – This study found a link between microplastics and chronic rhinosinusitis without nasal polyps. CRSsNP patients had much greater nasal lavage microplastic levels than healthy people. Data suggest that microplastics may cause or worsen CRSsNP by inflaming or irritating nasal mucosa.

Keywords: Chronic rhinosinusitis without nasal polyp, microplastics, NOSE

INTRODUCTION

Microplastics (MPs) are plastic particles smaller than 5 mm [1]. These particles are either intentionally created for usage in different sectors or result from the breakdown of bigger plastic components [1]. The environment is full of MPs, which can be found in food, soil, seas, the atmosphere, and constructed systems [2-4]. MPs are a major threat to natural systems and human health due to their pervasive existence. MPs in the atmosphere have been linked to respiratory illnesses and climate change [5-7].

The three main routes that MPs reach the human body are by ingestion, inhalation, and skin contact [8]. Human feces were found to contain MPs in 2019, suggesting accidental consumption from a variety of sources [9]. The human placenta, including the maternal, fetal, and amniochorionic membranes, has previously been shown to contain MPs [10]. MPs were also found in the lung tissues of non-smokers by Amato-Lourenco et al. [5]. Additionally, venous blood samples from healthy, non-fasting adult volunteers have been reported to contain a variety of MP types [11].

It has been demonstrated that micro-nanoplastics can trigger the processes required for the development of cancer.[12] It has been established that a micronanoplastic's capacity to cause genotoxicity is a reliable indicator of its carcinogenicity. According to some reports, there is a correlation between MPs' capacity to build up in cells and tissues and their potential to cause cancer.[13] Research on MPs typically focuses on the lower respiratory and gastrointestinal systems.

The first line of defense against infections entering the human respiratory system is frequently the nasal cavity, which traps these invaders. Thus, there is a great deal of curiosity in the existence of MPs in the sinonasal cavity and their consequences. When MPs get into the nasal cavity, they might damage the nasal tissues directly, which may make it easier for them to travel to other organs through nasal penetration [14]. Furthermore, it has been documented that MPs may induce pulmonary toxicity via a number of pathways, such as mitochondrial damage, DNA damage, and inflammasome activation.

Hence the present study was done to examine the relationship between chronic rhinosinusitis without nasal polyps and microplastics.

MATERIALS AND METHODS

The present prospective study was conducted at department of otorhinolaryngology , head and neck surgery of Dr DY Patil medical College , hospital and research centre for a study period of one year. Ethical clearance was taken from institutional ethics committee of college of college and hospitals and patients were asked to sign an informed consent form after explain them the complete procedure of the study.

Randomized sampling was done and a total of 50 patients diagnosed with Chronic Rhinosinusitis without nasal polyps and using nasal lavage treatment with saline (0.9% isotonic NaCl) were included in group A and 50 patients with any allergy related to nasal cavity without nasal polyp were considered in group B.

Patients were selected on the basis of following inclusion and exclusion criteria

Inclusion criteria-

1. Patients with age between 18 to 65 years of age
2. The diagnosis of CRSsNP occurs in cases, but controls do not have a history of CRS.
3. Patients undergoing surgery on the sinuses or the nose
4. Patients willing to participate in the study.

Exclusion Criteria

1. Patients with the presence of polyps in the nasal cavity
2. Patients with history of granulomatous disease, autoimmune disease, or sinonasal cancer is taken into consideration.
3. Patients with use of antibiotics or corticosteroids within the past three months
4.Patients with workplace exposure to microplastics (for example, workers at factories that manufacture textiles or plastics)

MATERIAL AND METHODS

All participants' gender and age were noted. All participants were given the Nasal Obstruction Symptom Evaluation (NOSE) questionnaire in their preferred language in order to gauge subjective nasal obstruction. The regular five-item scale was used to compute scores.

Procedure for Nasal Lavage

The participants were given instructions to use a 0.9% sterile isotonic saline solution for a nasal lavage. Each nostril received about 10 milliliters of saline, and the lavage fluid was gathered into sterile containers. Throughout the process, precautions were made to prevent contamination.

Analysis of Microplastics

Glass fiber filters with hole sizes of 1.2 µm were used to filter the collected nasal lavage fluids. To get rid of organic debris, the filters were digested for 48 hours at 60°C using 30% hydrogen peroxide ($H2O_2$). In order to verify the identity of the polymer, the residues were examined visually under a stereomicroscope and suspicious microplastic particles were further examined using Fourier Transform Infrared Spectroscopy (FTIR).

Every microplastic particle was described using the following criteria:

Shape (films, fibers, beads, and fragments)

Color

Category of size (>10 µm)

Type of polymer

Measures for Quality Control

Filtered deionized water was used to rinse all of the

instruments beforehand. In order to identify any possible environmental contamination, procedural blanks were handled concurrently. A laminar flow cabinet was used for all sample handling. To lower the danger of contamination, lab workers used cotton lab coats and non-shedding gloves.

Statistical analysis

Version 25.0 of the SPSS software (IBM Corp., Armonk, NY, USA) was used to analyze the data. Microplastic counts and participant demographics were summarized using descriptive statistics. For continuous data, the Student's t-test or Mann-Whitney U test was used for intergroup comparisons, and for categorical variables, the Chi-square test. Statistical significance was defined as a p-value of less than 0.05.

RESULTS

The mean age of patients in group A was 42.3 ± 10.5 and in group B was 40.1 ± 9.7. number of male patients in group A was 28 and in group B was 30. There was no statistically significant difference in age or gender distribution between the two groups as shown in table 1.

Table 1 Demographic Characteristics of Study Participants

Variable	Group A (n=50)	Group B (n=50)	*p*-value
Mean Age (years)	42.3 ± 10.5	40.1 ± 9.7	0.312
Gender (M/F)	28 / 22	30 / 20	0.482

The NOSE scores were significantly higher (<0.001) in the group A (65.4 ± 12.7) as compared to group B (18.2 ± 8.6), indicating more severe nasal obstruction symptoms compared to controls as shown in table 2.

Table 2 NOSE Score Comparison

Group	Mean NOSE Score ± SD	*p*-value
Group A	65.4 ± 12.7	<0.001
Group B	18.2 ± 8.6	

In nasal lavage samples, Group A (n=50) had substantially greater levels of microplastic contamination (12.6 ± 4.3) than Group B (n=50) (4.2 ± 2.1). 94% of Group A had microplastics, while only 60% of Group B did. In Group A, the average number of particles per sample was almost three times more. Fibers were the most commonly seen microplastic forms, and indicates that the predominant polymer types were polyethylene (PE), polystyrene (PS), and polypropylene (PP), which were present in both groups although in varying amounts as shown in table 3.

Table 3 Microplastic Particle Detection in Nasal Lavage Samples

Parameter	Group A	Group B	*p*-value
Mean MP count per sample	12.6 ± 4.3	4.2 ± 2.1	<0.001
% Samples positive for MPs	94% (47/50)	60% (30/50)	<0.001
Dominant MP shape	Fibers	Fibers	—
Common polymer types detected	PE, PS, PP	PE, PP	—
MP size range	>10 µm	>10 µm	—

DISCUSSION

Chronic rhinosinusitis (CRS) may be broadly defined as an inflammatory disorder of the paranasal sinuses and linings of the nasal passages that lasts 12 weeks or longer. It is multifactorial in nature and can include infectious, inflammatory, or structural factors. Thus, other etiologies such as allergic rhinitis (dust mites, molds), exposures (airborne irritants, cigarette smoke or other toxins), structural causes (nasal polyps, deviated nasal septum), ciliary dysfunction, immunodeficiencies, and fungal infections should be considered.[15]

Microplastics are the new irritants which are defined as "synthetic solid particles or polymeric matrices, with regular or irregular shape and with size ranging from 1 µm to 5 mm, of either primary or secondary manufacturing origin, which are insoluble in water." [16] Because they contain toxic substances that seep into the air, water, and food, microplastics pose a threat to both the environment and human health. The present study was done to examine the relationship between chronic rhinosinusitis without nasal polyps and microplastics.

The findings of present study showed that nasal lavage samples from patients with CRSsNP had a noticeably greater burden of microplastics than those from control group who did not have CRS allergic nasal symptoms. Furthermore, the CRSsNP group's NOSE ratings were noticeably higher, suggesting more severe subjective nasal blockage.

Our study contributes to the increasing amount of data indicating that microplastics can enter the upper

respiratory tract and may be a factor in local inflammatory diseases. The fact that MPs were found in 94% of patients with CRSsNP as opposed to 60% of controls is noteworthy and suggests that MPs may have a pathophysiological function in chronic sinonasal inflammation.

Prior studies have mostly examined the identification of MPs in human feces, lungs, blood, and even the placenta, indicating extensive systemic exposure via eating and inhalation pathways [9–11]. MPs were found in nonsmokers' lung tissues by Amato-Lourenco et al [5], supporting the idea that airborne microplastics could enter the respiratory mucosa and build up there. In a disease-specific setting, our study is one of the first to specifically evaluate the sinonasal cavity as a location of MP deposition The frequent detection of polyethylene (PE), polypropylene (PP), and polystyrene (PS) polymers, as well as the preponderance of fibers as the observed morphology, are consistent with patterns documented in other environmental and human research [6,7]. Because these polymers are widely found in consumer goods and industrial pollutants, breathing in contaminated air is likely to expose oneself to them.

The markedly elevated MP content in CRSsNP patients raises the possibility that MPs may be involved in initiating or aggravating mucosal inflammation. Chronic inflammation and epithelial dysfunction are linked to MPs because they have been shown to cause mitochondrial damage, reactive oxygen species (ROS) generation, DNA damage, and NLRP3 inflammasome activation [13,14]. These processes might be involved in the chronic sinonasal inflammation that characterizes CRSsNP, especially when polypoid alterations are absent and immunological dysregulation rather than structural blockage is more prevalent.

The results also support the Tuna et al. study [1], which found MP in patients with allergic rhinitis. Our work stands out, though, because it focuses on CRSsNP, a chronic inflammatory disease with a more complicated etiology. These patients' elevated MP burden raises the possibility that microplastics serve as environmental triggers that prolong chronic inflammation rather than just being allergies or irritants.

Our study had some limitations. First, even with stringent quality control procedures, ambient background contamination cannot be completely ruled out. Secondly, although FTIR was used to identify the polymer, a thorough examination of the particle load in connection to past environmental exposures (such as air quality, occupation, and residential proximity to industrial locations) was not carried out; this might be investigated in subsequent studies.

CONCLUSION

This study revealed a substantial correlation between microplastics and chronic rhinosinusitis without nasal polyps (CRSsNP). Patients with CRSsNP demonstrated significantly elevated concentrations of microplastics in their nasal lavage samples relative to healthy persons. The prevalence of fiber-shaped particles and the frequent identification of polymers including polyethylene, polystyrene, and polypropylene indicate that environmental exposure is a probable factor.

The data support the idea that microplastics may contribute to the etiology or aggravation of CRSsNP, possibly by localized inflammatory or irritative effects on the nasal mucosa. Additional research with bigger sample numbers and mechanistic analysis is necessary to elucidate the causal relationship and investigate preventive or therapeutic implications.

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