ORIGINAL ARTICLE

# Fungal Sensitization in Nasal Polyposis

F Muñoz-del-Castillo,[1] A Jurado-Ramos,[1] R Soler,[1] BL Fernández-Conde,[1] MJ Barasona,[2] E Cantillo,[1] C Moreno,[2] F Guerra[2]

[1] Department of Medicine, Dermatology and Otolaryngology, University of Córdoba, Córdoba, Spain
[2] Ear, Nose, and Throat and Allergology Services, Reina Sofía University Hospital, Cordoba, Spain

## Abstract

*Background:* There are indications that polyposis is somehow related to allergic phenomena. Fungal sensitization in substantial proportions of patients has been cited as a trigger of inflammatory mechanisms involving either an immunoglobulin (Ig) E-mediated reaction to fungal colonization or fungal invasion of tissues.
*Objective:* To confirm whether fungi were involved in the development of polyposis by examining sensitivity to fungal allergens and potential local contamination by fungal species.
*Methods:* We performed a study of 190 patients with polyposis and 190 controls in which we compared the results of skin prick tests to 12 fungi, total IgE, and specific IgE to 15 fungal extracts and nasal fungal cultures.
*Results:* The specific fungi eliciting a reaction from the largest proportion of patients in the skin prick tests were *Fusarium solani* (13.7%), *Penicillium frequentans* (12.6%), *Trichophyton mentagrophytes* (11.1%), and *Candida albicans* (8.4%) ($P < .001$). The proportion of individuals that tested positive for fungal-specific IgE was 22.4% (38/170) for patients and 10.1% (19/189) for controls ($P = .04$). The respective proportions of positive responses to fungal cultures were 58.7% and 60%. Furthermore, no significant differences between patients and controls were found for the results of in vitro tests with cultured fungal allergens.
*Conclusions:* Although the patients with polyposis exhibited sensitization to fungal allergens, we found that nasal colonization by fungi was similar in patients and the general population. We were also unable to find a correlation between a positive response to the cultures and the presence of fungal allergen-specific IgE. It therefore seems that nasal colonization by fungi does not induce fungal sensitization.

Key words: Chronic rhinosinusitis. Fungal allergy. Fungal cultures. Immunoglobulin E-mediated phenomena. Molds. Nasosinusal polyposis. Pneumoallergens.

## Resumen

Existen indicios de asociación entre la poliposis y los fenómenos alérgicos. Se han elaborado estudios en los últimos años, buscando un posible alérgeno que sea el origen del proceso inflamatorio eosinofílico. En diferentes trabajos se ha observado una sensibilización a hongos en una proporción importante de pacientes como posible origen de la estimulación de los mecanismos inflamatorios, bien mediante una respuesta inmune mediada por IgE a la colonización por hongos o bien por la invasión fúngica de los tejidos.
*Métodos:* Se ha realizado un estudio sobre 190 pacientes con poliposis y un grupo control de 190 sujetos sanos, comparando los resultados de prick-tests a un panel de 12 hongos, IgE total, IgE específicas a 15 alérgenos fúngicos (CAP-System) y cultivos fúngicos nasales de ambos grupos.
*Resultados:* En el grupo de pacientes con poliposis, los resultados positivos más frecuentes de los prick-test fueron: *Fusarium solani* (13,7%), *Penicillium frecuentans* (12,6%), *Trichophyton mentagrophytes* (11,1%) y *Candida albicans* (8,4%), existiendo diferencias estadísticamente significativas. El porcentaje de pacientes con IgE específica a hongos positiva (al menos a una especie de hongo) fue del 22,4% (38/170) frente al 10,1% de los controles (19/189) con $P = 0{,}04$. Los cultivos nasales fúngicos fueron positivos en el 58,7% de los pacientes y el 60% de los controles. En el análisis de los cultivos de hongos según los resultados de los test *in vitro* a alérgenos fúngicos, tampoco se observaron diferencias estadísticamente significativas.
*Conclusiones:* Existe una sensibilización a alérgenos fúngicos en los pacientes con poliposis nasosinusal de nuestro estudio. Sin embargo, no existe una colonización nasal por hongos diferente a la población general, no comprobándose una asociación entre los resultados positivos de los cultivos y la existencia de IgE específica a alérgenos fúngicos, por lo que se descarta la teoría de la sensibilización a hongos por la colonización nasal.

Palabras clave: Alergia a hongos. Fenómenos IgE-mediados. Cultivos fúngicos. Poliposis nasosinusal. Mohos. Neumoalérgenos. Rinosinusitis crónica.

## Introduction

Although the exact origin of nasal polyposis remains unclear, a number of factors of an allergic [1,2], infectious, inflammatory, anatomical [3], and genetic nature [4] are known to be involved. Although no single etiopathogenic factor underlying the development of polyps has been identified, the different mechanisms potentially involved may converge on a common final pathway. Nevertheless, nasal polyposis remains a poorly understood chronic entity. Furthermore, there is no effective long-term treatment and recurrence is common.

Several studies have indicated a potential relationship between nasal polyposis and allergy [1,2]. Indeed, nasal polyposis is clinically similar to perennial rhinitis in that it features increased eosinophil counts and immunoglobulin (Ig) E specific to various pneumoallergens. Other characteristics of nasal polyposis include the presence of cytokines, chemokines, and other inflammatory mediators and an increased expression of adhesion molecules in polyps.

Several studies have sought to confirm whether eosinophil-mediated inflammatory processes are due to the action of a specific allergen such as a fungus [5,6], a type of food [1], or a bacterial superantigen [7-10]. It has been suggested, for example, that fungi might play a role in the development of chronic rhinosinusitis with polyposis, either by eliciting an immune response to fungal colonization (fungal allergy) or by invading tissue [5,6]. Such reactions could result in eosinophil-mediated inflammation and tissue damage. Asero et al [2] found patients with polyposis to exhibit fungal sensitization, particularly to *Candida albicans*, although it has been noted that *Candida* is a controversial genus [11]. Ponikau et al [5], in a study of patients with chronic rhinosinusitis, detected fungi in 96% of nasal secretion cultures and identified 40 different fungal species in the nasal sinuses.

The aim of the present study was to confirm whether or not fungi were involved in the development of nasal polyposis by examining sensitivity to fungal allergens and potential local contamination by various fungal species with a view to establishing their role in polyp formation and hence in IgE-mediated phenomena such as pathogenic action in the form of nasal colonization.

## Material and Methods

A cut-off study involving 190 patients with nasal polyposis and 190 healthy individuals without either chronic rhinosinusitis or nasal polyposis (confirmed by nasal endoscopy) was performed. Nasal polyposis was diagnosed when bilateral polyps were identified by nasal endoscopy in accordance with the classification guidelines in the 2007 European Position Paper on Rhinosinusitis and Nasal Polyps [12]. The patients were individuals aged 18 years or older seen at the ear, nose, and throat outpatient department of the Reina Sofía University Hospital in Córdoba, Spain. All the participants signed an informed consent form and the study was approved by the local ethics committee.

The diagnostic methods included skin prick tests (SPTs) using a battery of 12 fungal allergens, serum determinations of total IgE and IgE specific to 15 different fungal allergens, and tests with cultures of polyps and nasal secretions in special fungal media.

SPTs were performed using standardized steel lancets (Allergy Pricker; Dome Hollister Stier, Spokane, Washington, USA) and positivity was defined in accordance with the recommendations of the Subcommittee on Allergen Standardization and Skin Tests of the European Academy of Allergy and Clinical Immunology, that is, a skin response was considered positive if the resulting wheal was as large as or larger than that produced by the positive control (histamine) [13]. Negative controls consisted of glycerin-containing saline and positive controls of 10 mg/mL histamine. The allergenic extracts were from the commercial battery CBF LETI (Alergia, S.A., Barcelona, Spain). The pneumoallergens included in the battery are listed in Table I.

Fungal allergen-specific IgE levels were determined using the CAP system as recommended by the manufacturer (Phadia AB, Uppsala, Sweden). The allergen panel used comprised the following 15 fungi: *Alternaria alternata, Aspergillus fumigatus, Cladosporium herbarum, Penicillium notatum, Penicillium frecuentans, Mucor racemosus, Fusarium solani, Pullularia pullulans, Rhizopus nigricans, Curvularia lunata, Trichophyton mentagrophytes (var. goetzii and interdigitale), Pityrosporum orbiculare*, and *C albicans.*

The samples used in the fungal cultures were obtained directly from the study individuals. Samples of nasal polyps and secretions from the patients with polyposis were obtained using Blackesley-Weill sterile forceps under aseptic conditions (aseptic surgery material and laminar

Table 1. Number (%) of Patients and Controls With a Positive Skin Test to Fungal Allergens and Statistical Significance of Results

| Allergen | Patients | Controls | *P*[a] |
|---|---|---|---|
| *Fusarium solani* | 26 (13.7) | 2 (1.1) | < .001 |
| *Penicillium frecuentans* | 24 (12.6) | 2 (1.1) | < .001 |
| *Trichophyton mentagrophytes* | 21 (11.1) | 1 (0.5) | .001 |
| *Candida albicans* | 16 (8.4) | 3 (1.6) | .07[b] |
| *Alternaria alternata* | 13 (6.8) | 6 (3.2) | .66[b] |
| *Aspergillus fumigatus* | 13 (6.8) | 0 | .001 |
| *Penicillium notatum* | 12 (6.3) | 3 (1.6) | .1[b] |
| *Curvularia lunata* | 11 (5.8) | 1 (0.5) | .06[b] |
| *Mucor racemosus* | 11 (5.8) | 1 (0.5) | .14[b] |
| *Rhizopus nigricans* | 9 (4.7) | 0 | .02 |
| *Cladosporium herbarum* | 8 (4.2) | 1 (0.5) | .22[b] |
| *Pullularia pullulans* | 8 (4.2) | 1 (0.5) | .05 |

[a] P value adjusted using the Mantel-Haenszel procedure.
[b] Statistically nonsignificant differences.

flow in endoscopy room), and nasal secretion samples from the controls were obtained using sterile cotton swabs. The nasal samples from both the patients and the controls were placed in tightly closed sterile tubes containing Sabouraud-Chloramphenicol medium and immediately submitted to the laboratory for processing. Once in the laboratory, surgical pieces were homogenized in a mortar by gentle grinding with sand, using sterilized material in a laminar flow hood under aseptic conditions. The homogenates thus obtained were used to seed plates containing Sabouraud agar, Czapek Dox agar, and Malta agar for subsequent isolation and identification of fungi.

The plates holding the inocula corresponding to each sample were incubated at 25ºC for 4 weeks with monitoring on a weekly basis [14,15]. Identification was based on the microscopic and macroscopic characteristics of the mold colonies growing on the plates. The microscopic study involved direct examination of a small portion of each colony after addition of potassium hydroxide or lactophenol cotton blue. Colonies in which no reproductive structure were identified were also examined in slide cultures.

### Statistical Analysis

Significance was determined using an unpaired *t* test with *P* values adjusted between the 2 groups following the Mantel-Haenszel procedure. The Mann-Whitney test was used to compare the determination of total IgE in serum between patients and controls. The correlation between fungal sensitization and polyposis was determined using the $\chi^2$ test as implemented by Mantel and Haenszel and adjusted for the presence of atopy. Pearson's $\chi^2$ test was used to compare the fungal species most frequently detected in the patient and control cultures and to test the correlation between fungal cultures and IgE specific to fungal allergens. The level of significance was set at a *P* value of .05.

## Results

### Skin Prick Test Results for Fungal Allergens

The results of the fungal allergen SPTs conducted on the patients and the controls are summarized in Table 1. The fungi that elicited a reaction from the highest proportions of patients with nasal polyps in these tests were *F solani*, *P frecuentans*, and *T mentagrophytes*. Those that caused sensitization in the highest proportions of controls were *A alternata*, *C albicans*, and *P notatum*. There were statistically significant differences between the 2 groups (see Table 1).

### Determination of Total IgE in Serum

Of special interest among the results of the immunological study was the fact that the total IgE concentrations were all below 200 IU/mL and within the normal ranges for adults over 18 years of age according to the immunology laboratory at the Reina Sofía University Hospital. In comparison, the test revealed significant differences ($P < .001$) between the results for the 2 groups. The proportions of individuals with increased total IgE levels were significantly different at $P = .05$.

### Determination of Fungus-Specific IgE

Of the 190 patients with polyposis, 170 were tested with fungal allergens using the CAP system. The number of positives (IgE concentration, > 0.35 kU/L) were as follows: 13 (7.6%) for *T mentagrophytes* var. *goetzii*, 9 (5.3%) for *T mentagrophytes* var. *Interdigitale*, 12 (7.1%) for *C albicans*, and 7 (4.1%) for *A alternata* (Table 2). Thirty-eight patients (22.4%) tested positive to at least 1 fungal species compared to 19 controls (10.1%). No significant differences were observed between the groups as regards fungus-specific IgE although there were significant differences in terms of fungi as a whole ($P = .04$, Table 2).

Table 2. Positive Fungal Allergen-Specific Immunoglobulin (Ig) E Test Results in Patients (n = 170) and Controls (n = 190)

| Specific IgE | Patients, No (%) | Mean, kU/I | Controls, No. (%) | Mean kU/L | *P* |
|---|---|---|---|---|---|
| *Alternaria alternata* | 7 (4.1) | 2 | 3 (1.6) | 1.55 | .86 |
| *Aspergillus fumigatus* | 5 (2.9) | 0 | 0 | 0 | .07 |
| *Aspergillus niger* | 5 (2.9) | 5 | 0 | 0 | .07 |
| *Cladosporium herbarum* | 0 | 0 | 1 (0.5) | 0.3 | .71 |
| *Penicillium notatum* | 2 (1.2) | 5 | 0 | 0 | .44 |
| *Penicillium frecuentans* | 1 (0.6) | 0 | 2 (1.1) | 50.1 | .81 |
| *Mucor racemosus* | 3 (1.8) | 0 | 0 | 0 | .52 |
| *Fusarium solani* | 3 (1.8) | 1 | 0 | 0 | .29 |
| *Pullularia pullulans* | 5 (2.9) | 2 | 1 (0.5) | 7.82 | .44 |
| *Rhizopus nigricans* | 2 (1.2) | 0 | 1 (0.5) | 22.7 | .56 |
| *Curvularia lunata* | 3 (1.8) | 8 | 1 (0.5) | 29.3 | .83 |
| *Trichophyton mentagrophytes*[a] | 13 (7.6) | 4 | 5 (2.6) | 22.3 | .09 |
| *Trichophyton mentagrophytes*[b] | 9 (5.3) | 3 | 3 (1.6) | 24.3 | .11 |
| *Pityrosporum orbiculare* | 3 (1.8) | 2 | 3 (1.6) | 15.6 | .92 |
| *Candida albicans* | 12 (7.1) | 1 | 3 (1.6) | 1.4 | .14 |
| Positive fungus-specific IgE, % of total | 22.4 | | 10.1 | | .04 |

[a] var. goetzii
[b] var. interdigitale

 

### *Fungal Cultures*

Polyp samples from 138 patients and nasal secretions from 30 controls were cultured. In total, 58.7% of patients (n = 81) and 60% of controls (n = 18) tested positive for some fungus. Table 3 shows the fungal species most frequently detected in both groups. No statistically significant differences were found on comparing the results for the 2 groups (odds ratio, 0.94; confidence interval [CI], 0.42-2.11). Based on the nasal colonization rate in the patient and control groups, patients with nasal polyposis and healthy individuals have a similar likelihood of testing positive for fungal cultures.

### *Correlation of Variables: Fungal Cultures and IgE Specific to Fungal Allergens*

Fifteen patients that tested positive for fungal allergens in the radioallergoabsorbent test (15/170, 8.8%) also tested positive for fungal cultures. In contrast, 23 patients (13.5%) tested positive for fungus-specific IgE but negative for fungal cultures. Pearson's $\chi^2$ test revealed the absence of statistically significant differences ($P = 0.69$) and yielded an odds ratio of 0.85 for a positive fungal culture (CI, 0.39-1.81). Testing positive for fungal cultures, therefore, does not necessarily mean doing so for fungus-specific IgE, which is the basis of the assumption that fungal colonization of the nasal sinuses can result in sensitization to fungi.

Table 3. Most Common Fungal species in Nasal Polyp Cultures From Patients (81 Positives in 138 Cultures) and Controls (18 Positives in 30 Cultures)

| Species | No. (%) of Patients | No. (%) of Controls |
|---|---|---|
| *Penicillium* | 33 (40.7) | 9 (50.0) |
| *Alternaria* | 21 (25.9) | 2 (11.1) |
| *Yeasts* | 19 (23.4) | 7 (38.8) |
| *Absidia* | 12 (14.8) | 2 (11.1) |
| *Ulocladium* | 10 (12.3) | 1 (5.5) |
| *Helminthosporium* | 9 (11.1) | 1 (5.5) |
| *Aspergillus* | 9 (11.1) | 4 (22.2) |
| *Mucorales* | 8 (9.8) | 0 (0) |
| *Pullularia* | 6 (7.4) | 1 (5.5) |
| *Fusarium* | 6 (7.4) | 3 (16.6) |
| *Cladosporium* | 5 (6.1) | 1 (5.5) |
| *Bipolaris* | 3 (3.7) | 1 (5.5) |
| *Acremonium* | 3 (3.7) | 1 (5.5) |
| Not identified | 10 (12.3) | 1 (5.5) |

## Discussion

The origin of nasal polyposis is highly controversial and has been the subject of many theories and assumptions. In recent years, an allergic origin has been favored [1,2,16-18] under the assumption that allergy is a predisposing factor for polyposis. The formation of nasal polyps has also been ascribed to immunological responses leading to inflammatory phenomena; such responses might be caused by an allergen, meaning that the polyps would have an allergic origin.

In the absence of standardized fungal extracts, the role of fungi as allergens remains unclear. Furthermore, the tests involved are not routinely prescribed, so no epidemiologically useful data in this respect are available. Fungal allergy is a problem worldwide but while fungal spores can be found anywhere [19-21], exposure only occurs through contact with saprophytes or food intake.

Occupational exposure to fungal derivatives has been found to elicit symptoms in sensitized patients [22]. Respiratory symptoms in such individuals may be caused by allergy, inflammation, or irritation of the airways, among others. Exposure to antigenic structures triggers an immune reaction against a potential invasion by producing antibodies against fungal antigens [23].

The fungal species that have been most frequently associated with allergic rhinitis to fungal antigens are *Alternaria*, *Aspergillus*, *Candida*, *Mucor*, *Penicillium* and *Cladosporium* [24]; all were studied here. Although there is little information about the prevalence of fungal allergies among the general population, that among patients with chronic rhinosinusitis is estimated to be in the region of 52% [25].

Based on previous results, Mari et al [26,27] estimated the prevalence of fungal allergy on the basis of skin tests and correlated this with fungus-specific IgE antibody levels with a view to comparing in vivo and in vitro measurements. Of the 4962 patients with respiratory disease (asthma or rhinitis), 65.5% exhibited at least 1 positive STP response, and of these, 19.1% tested positive for some fungus. These results are consistent with ours.

In order to reassess the diagnostic criteria for allergic fungal rhinosinusitis (AFRS) prevalence in patients with chronic rhinosinusitis, Ponikau et al [5] conducted a prospective study in 210 such patients with and without nasal polyposis and a control group. They performed SPTs with 18 fungal allergens in both groups and found 25% of the patient group to exhibit a positive response to at least 1 allergen.

In a study by Asero et al [2], 55% of patients with polyposis exhibited skin reactivity to at least 1 allergen; 45% of these patients responded to some fungus. Indeed, 40% of the group (compared to only 1% in the control group) reacted to *C albicans*; these figures are much higher that those for our series. However, the authors themselves questioned the potential allergenicity of allergic fungal rhinosinusitis *Candida* arguing that the effect of its inoculation might simply be a nonspecific inflammatory reaction not mediated by IgE.

In a study by Stroud et al [28], reactivity to fungi was found in 65% of patients and reactions to *Fusarium*, followed by *Alternaria* and *Pullularia*, were particularly common; their figures were considerable higher than ours.

In our study, 22.4% of patients with nasal polyposis with allergy signs and symptoms had positive IgE to some fungal allergen in the test battery. This contrasted with only 10.1% of the controls. Following correction for atopy, the 2 variables were found to be significantly correlated, although there were no statistical differences for specific IgE for any of the species isolated.

Assessing allergy to fungi is key to correctly identifying the offending fungus and initiating appropriate treatment. Diagnosing fungal allergy is difficult for various reasons including the absence of a clear-cut seasonal pattern and

the large variety of fungi present in the environment, which hinders their accurate identification [25,26]. In vitro tests have enabled the identification of some fungal species [29,30] and proven to be a useful screening and diagnostic tool for allergy to inhaled antigens.

Mabry et al [31,32] studied the sensitivity of patients with AFRS by using specific IgE and SPT, and found that these were correlated in most instances. Differences arose mainly from the increased sensitivity of SPT to some fungi from the *Dematiaceae* family.

King [29,30] tested various fungi in 375 patients using the radioallergosorbent test and found sensitization to be caused mainly by *Alternaria, Fusarium, Curvularia* and *Mucor* species; his results, however, departed from those of other studies in terms of the prevalence of allergy to specific fungi. Corey et al [33], for example, reported a prevalence of fungal allergy of 44% among patients with atopic rhinitis and found that the most prevalent fungi were *Alternaria*, *Helminthosporium*, and *Aspergillus*.

Only 37% of patients exhibited increased total IgE levels in the above-mentioned study by Poinkau et al [5], and only 28% exhibited increased fungus-specific IgE levels; there were no significant differences in IgE levels between patients and controls. According to those authors, there were indications against the theory of a type I hypersensitization mechanism, although IgE might be locally triggered by the nasal mucosa and not increased in blood as hypothesized in other studies [34]. Poinkau et al concluded that a potential role of IgE in the physiopathology of AFRS was unlikely and that the presence of eosinophils in itself did not constitute a solid criterion for diagnosing allergy. They believed that fungi trigger most episodes of chronic rhinosinusitis and that the local production of IgE by the nasal mucosa in the presence of eosinophilia is a response to fungal colonization rather than a type I or IgE-mediated response.

Corradini et al [35] found fungi in nasal secretions from all patients and therefore excluded a potential systemic allergic reaction to fungi. In 2003, Weschta et al [36] concluded that *Aspergillus*-specific IgE was very rarely detected in patients with polyposis, and Marple [37] estimated that 7% of patients with chronic rhinosinusitis who had been surgically treated for polyposis had allergic fungal rhinosinusitis, even though the disease only manifested at a late stage in some cases. Despite the controversy, the origin of AFRS appears to involve an IgE-mediated process but whether or not such a process is a major factor or a result of other factors is not known [38,39].

Based on the results of our study, we believe that AFRS is a highly heterogeneous clinical entity whose accurate diagnosis requires the application of strict criteria. These criteria are being continuously revised in response to the difficulty of finding patients meeting all of them. If we apply the diagnostic criteria of positivity to nasal fungal cultures and fungal allergen-specific IgE and the presence of polyps in our series, 8.8% of our patients had AFRS. If we further include the results of radiological tests and the presence of allergic mucin—which, together, constitute the criteria of Bent and Kuhn [38]—then the number of patients with AFRS falls to 2 (1.1%).

The results of the fungal culture tests in the 2 groups revealed a similar extent of fungal colonization of the nasal sinuses. In other words, the nasal sinuses were colonized by different fungal species, possibly via physiological mechanisms, but at similar rates in patients with polyposis and in controls.

A comparative analysis ruled out a potential correlation between a positive culture test and the presence of fungus-specific IgE, which is the basis of the theory of sensitization by fungal colonization of the nasal sinuses. Fifteen patients with fungus-specific IgE also had positive culture tests. The specific fungi found in the nasal sinuses appear to lack the pathological significance they would have if they were directly involved in the origin of the polyps. Rather, they appear to be colonies of saprophytic fungi inhabiting cavities connected with the outer environment in similar proportions in patients and controls.

Dosa et al [40] examined samples from patients with chronic rhinosinusitis by microscopic inspection and culturing in various media. They found fungi in 79 patients (83%), a figure which exceeds that of our study. In total they identified 237 different types of fungi, the most common of which were *C albicans*, *Cladosporium* spp, and *P notatum*. In a healthy control group, they found fungi in 22 individuals (44%) and the species detected were similar in number and proportion to those detected in the patients. Khoo et al [41] found 13 different types of fungi in the nasal sinuses and rhinopharynx of healthy individuals, in proportions similar to those of our study.

Vennewald et al [42] found 24.9% positivity to fungal cultures (particularly those of *A fumigatus*, *A alternata*, and *P notatum*), suggesting nasosinusal colonization by commensal fungi rather than infection (ie, mycosis). Nasosinusal fungal colonization is caused by an overproduction of mucus, which hinders ciliary clearance and provides a culture broth for fungi. In the study by Ponikau et al [5], 96% of patients tested positive for fungal cultures from nasal secretions; this figure is much higher than ours. The authors identified a total of 40 fungal species. A recent study by Taylor et al [43] found an increased detection sensitivity of fluorescein-labeled chitinase for fungal hyphae in eosinophilic mucin relative to other stains; in fact, chitinase revealed the presence of fungi in all of the patients with rhinosinusitis. These results are suggestive of fungal colonization of the nasal sinuses in both patients and healthy controls, and are thus consistent with our findings.

In conclusion, we found patients with nasosinusal polyposis to exhibit sensitization to fungal allergens. However, the prevalence of nasal colonization by fungi was essentially the same as in the general population (healthy controls). In fact, no correlation between positives for fungal cultures and the presence of fungal allergen-specific IgE was found. This excludes the possibility that fungal sensitization might be caused by nasal colonization. Nasosinusal polyposis is a clinical entity of multifactor etiology which involves self-perpetuated inflammatory phenomena of unknown origin. Although allergy is a coadjuvant here, its exact role cannot be defined at present.

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**Francisco Muñoz del Castillo**

Facultad de Medicina, Universidad de Córdoba
Avda. Menéndez Pidal, s/n
14004 Córdoba, Spain
E-mail: verywhite2000@hotmail.com

 