



Frequency of fungal agents identified in sinus samples from patients with clinically suspected rhinosinusitis



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ABSTRACT

Fungal rhinosinusitis (FRS) is one of the most important rhinosinusoidal disorders, which involves a variety of etiological agents. We carried out a study to determine the frequency of fungal agents in sinus samples from patients with clinically suspected rhinosinusitis (RS). A total of 205 clinical samples were assessed from 174 patients with clinically suspected RS, of which 48 were positive for microscopic examination and culture, 47 were positive for direct examination but negative by culture, 4 were negative for direct examination but positive by culture, and 106 were negative for both methodologies. The main fungal agents isolated were *Aspergillus* spp. (32.7%), followed by *Schizophyllum commune* (28.8%). Sensitivity and specificity of the direct examination were 92.3% and 69.3%, respectively, and concordance between the direct examination and culture was 48.4%. This study indicated that both *Aspergillus* and *S. commune* appear to be the most important agents involved in the development of FRS.

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1. Introduction

Sinusitis or rhinosinusitis (RS) is a common disorder, which is characterized by inflammation of the mucus membrane lining the paranasal sinuses and is very heterogeneous in its clinical and pathological presentations (Braun, 2003; Chan and Kuhn, 2009). This disease is highly prevalent and is estimated to affect approximately 20% of the population at some time in their lives (Chakrabarti et al., 2009; Fonseca and Fernández, 2005; Granville et al., 2004; Jofre et al., 2009). Sinusitis may be caused by allergic, irritant, or infectious agents and can be classified into several categories according to the affected sinus (ethmoidal, maxillary, frontal, or sphenoidal) and etiological agent involved (virus, bacteria, and fungi), among others (Braun, 2003; Chan and Kuhn, 2009).

RS is characterized by the presence of 2 or more symptoms including nasal congestion, discharge, and obstruction accompanied by facial pressure or pain and loss of the sense of smell. This may be accompanied by endoscopic manifestations such as presence of polyps or mucopurulent discharge from the middle meatus with edema and mucosal obstruction (Jofre et al., 2009). Moreover, this infection can be acute (ARS) or chronic (CRS) (Chakrabarti et al., 2009; Granville et al., 2004). ARS is well characterized (Chakrabarti et al., 2009; Granville et al., 2004) and is associated with a viral infection of the upper tract (Granville et al., 2004), where it usually affects the maxillary and ethmoidal sinuses (Braun, 2003; Brook, 2005). Chronic presentations comprise over 90% of cases (Chakrabarti et al., 2009), in some of which

surgery may be required as treatment or to obtain tissue biopsies for an accurate diagnosis (Granville et al., 2004). However, different diagnostic criteria and treatment may be used to combat this infection (Ebbens et al., 2009; Jofre et al., 2009; Mowry et al., 2008; Ponikau et al., 1999; Won et al., 2012). In the majority of cases, microbiological diagnosis of CRS is considered to be unnecessary, and the condition is treated empirically (Braun, 2003). In complicated cases, diagnosis is confirmed by culturing tissue samples or secretions obtained through endoscopic aspirates of the affected sinus (Braun, 2003).

Although CRS may be caused by several conditions, the majority of cases are due to fungal infections (Granville et al., 2004).

Fungal RS (FRS) can be classified according to its histopathological characteristics and clinical presentation; thus, the invasive forms may be necrotizing acute, chronic, or granulomatous, while the noninvasive categories include fungal ball and allergic fungal sinusitis (Crisci, 2010; Fonseca and Fernández, 2005; Vallejo et al., 2005).

There are a variety of causative agents of FRS (Chakrabarti et al., 2009; Davis and Kita, 2004; López-Vázquez et al., 2012; Montone et al., 2012; Mowry et al., 2008; Vallejo et al., 2005), and its prevalence varies with geographic location (Chakrabarti et al., 2009; Krishnan et al., 2009; Montone et al., 2012; Ponikau et al., 1999; Taxy, 2006; Won et al., 2012). Among these agents are hyaline molds such as *Aspergillus* spp. and *Fusarium* spp.; dematiaceous molds including *Bipolaris* spp., *Curvularia* spp., and *Alternaria* spp. (Alvarez et al., 2011; Castro et al., 2010; Chakrabarti et al., 2009; Ponikau et al., 1999); and yeasts such as *Candida* spp. (Vallejo et al., 2005; Vergara and Hernández, 2007). Colonization by Mucorales includes *Rhizopus* spp., *Lichtheimia* (*Absidia* spp.), and *Mucor* spp. (Davis and Kita, 2004); in this case, the infection is considered

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infrequent and opportunistic (Vergara and Hernández, 2007). Other genera such as *Cladosporium*, *Penicillium*, *Exophiala*, and *Phialophora* and other species including *Fonsecaea pedrosoi*, *Scedosporium prolificans*, and *Neoscytalidium dimidiatum* have been reported among the major causative agents of RS (Vallejo et al., 2005; Vergara and Hernández, 2007). The most frequent route of colonization of the sinus is via inhalation of spores (López-Vázquez et al., 2012; Vergara and Hernández, 2007) or by direct inoculation (Vergara and Hernández, 2007). The immunological status of patients is known to determine the development of diseases (Maltrana et al., 2004); thus, invasive forms of FRS are typical in immunocompromised patients (Davis and Kita, 2004; Maltrana et al., 2004; Vélez and Rosso-Suárez, 2012; Vélez et al., 2012), whereas noninvasive forms are the most common presentations in immunocompetent individuals (Chanqueo et al., 2009; Maltrana et al., 2004). In recent years, the growth in numbers of patients with some degree of immunodeficiency (transplants, immunosuppressive drugs, diabetes, HIV infection, and leukemias, etc) has resulted in an increase in the invasive forms of FRS (Maltrana et al., 2004). Fungi often produce complications in patients with underlying diseases (Vergara and Hernández, 2007; Taxy, 2006), *Aspergillus* spp. mainly affecting those with hematological malignancies (Navarro-Chavarría and Romero-Pérez, 2008; Vélez and Rosso-Suárez, 2012), while *Mucorales* is found in diabetics (Davis and Kita, 2004; Maltrana et al., 2004; Vergara and Hernández, 2007). Accurate diagnosis and classification of the clinical forms of FRS involved are, therefore, crucial to prognosis and treatment (Granville et al., 2004).

Diagnosis of FRS is based not only on clinical symptoms but also on histological and radiological studies, including computed tomography. Culture, serology, and other techniques are also employed to a lesser extent (Granville et al., 2004; Maltrana et al., 2004). Although microscopic examination is the ideal and fastest method of diagnosis (Maltrana et al., 2004), fungal identification not always is possible, complicating selection of the most appropriate antifungal (Castro et al., 2010; Fonseca and Fernández, 2005; Maltrana et al., 2004; Mowry et al., 2008; Ponikau et al., 1999). Fungal culture is negative in more than 50% of cases and may also be positive in healthy individuals (Ebbens et al., 2009; Mowry et al., 2008; Ponikau et al., 1999). In most cases, positivity is associated with contamination of the culture media, which makes it difficult to isolate and identify the causative agent of the disease. On the other hand, fungal colonization is seen in some individuals who do not present an inflammatory response.

Therapeutic treatment and management of FRS depend on whether it is invasive or not. If so, high doses of intravenous antifungals are used, and in some cases, radical surgery may be required; nevertheless, pharmacological treatment of this mycosis is nonspecific (Maltrana et al., 2004), and the probability of relapses is high (Vélez and Rosso-Suárez, 2012). For this reason and because the treatment used for this mycosis differs according to the clinical manifestation involved, a correct and efficient diagnosis is crucially important; furthermore, it is imperative that the etiological agent be identified (Maltrana et al., 2004; Won et al., 2012) since this is the only way of improving the prognosis of these patients and allowing a timely and early specific treatment regimen to be established.

Taking into account that, in Colombia, little is known about FRS and the etiological agents involved, we performed a retrospective study, analyzing microbiological data obtained from processed samples of suspected cases in a mycological center in Medellín. Our objectives were to detect and identify fungal agents in clinical samples from patients with RS and determine the effectiveness of the direct examination and culture protocol used, as a first step toward establishing the frequency of the main fungal agents involved in the FRS in Colombia.

2. Subjects and methods

2.1. Research protocol

A retrospective cross-sectional study was performed on patients with RS whose samples were sent to the Medical and Experimental

Mycology Unit at the Corporación para Investigaciones Biológicas (CIB) in Medellín, Colombia. Microbiological results (direct examination and culture) obtained by processing samples of patients attended in different hospitals of the city between the years 2000 and 2012 were included in the study. A total of 205 samples were analyzed from 174 patients.

2.2. Data collection and analysis

2.2.1. Inclusion criteria

The medical records of selected patients with clinical suspicion of RS with at least the following information are included: name, age, gender, and results of direct examination and/or culture results.

2.2.2. Exclusion criteria

All records of patients with incomplete data were excluded, especially those who had no culture or direct examination results.

2.3. Microbiological procedures

Samples obtained from patients with clinical suspicion of RS included aspirates, biopsies, and sinus secretions. All samples were handled according to the standardized protocols of the institution. Each sample was assessed using direct examination with 10% KOH. This method is rapid but has a relatively low diagnostic sensitivity, so that fungal infection can never be completely discounted from a negative result of a direct examination. Samples were subsequently cultured in different culture media already in routine use at the mycology laboratory, i.e., Mycosel, Sabouraud, and potato dextrose agar (PDA) and incubated at room temperature for approximately 30 days. Although this method is the most widely used for the diagnosis of mycosis, positivity is only about 50%. This procedure thus cannot be used as a sole diagnostic tool, and correlations must be made between clinical symptoms and the results of direct examination and culture. Sabouraud and Mycosel culture media were purchased from Becton Dickinson, NJ, USA, whereas PDA medium was prepared in our laboratory from components that included granulated agar (Becton Dickinson, USA), glucose (SIGMA-Aldrich, St. Louis, MO, USA), and potato flakes.

All fungi isolated by culture were identified by their macroscopic and microscopic characteristics. In some cases, identification was not possible due to the inability of the fungus to sporulate. The specific identities of organisms such as *Candida* spp. were confirmed using CHROMagar *Candida*® culture medium (CHOMagar Microbiology, Paris, France) and sugar assimilation tests with the commercial kit API 20C Aux (Biomerieux, Marcy, L'Etoile, France).

In those cases where direct examination was negative and the fungal isolation in culture was reported, this was interpreted according to criteria such as pure culture growth and growth of fungal colonies on all seeded points.

2.4. Data handling and statistical analysis

Microbiological data and clinical characteristics of the records obtained from the mycological center were entered in a standardized form prepared for that purpose and stored in a specially designed database of Microsoft Excel®.

The independent variables analyzed included sex, age, localization of the lesion, direct examination, and culture, in all cases for which information was available. The dependent variables included negative results from both direct examination and culture, positive results from both direct examination and culture, direct examination positive and culture negative, and direct examination negative and culture positive. Descriptive statistics were used for data analysis, with absolute and relative frequencies measures calculated for all variables analyzed. In order to determine the correlation between the direct examination and

culture, Kappa analysis was performed, using the statistical software EPIDAT version 3.1.

2.5. Ethical considerations

The present study was conducted according to the Helsinki Declaration and Colombian national laws under which it was categorized as “research without risk”. The study was based on secondary information, with no primary biological, physiological, psychological, or social variables. The authors did not interact with patients or perform any manipulation of their clinical samples, worked being confined to reviewing some of the clinical and laboratory data contained in their records.

3. Results

In all, 174 patients with clinical diagnosis of RS were studied, of which 108 (62.1%) were female and 66 (37.9%) male. A total of 205 samples were analyzed. All samples had been processed for direct examination and mycological culture; taking into account the objective of this study, media for bacterial isolation were not used. Ages of the patients analyzed are summarized in Table 1. The largest group of patients consisted of adults between 26 and 45 years old (37.4%) followed by those aged 46–60 years (27.0%), then those over 60 (17.2%). Children under 15 made up most of the remainder of the group (12.1%). In cases of patient who presented relapses (6 patients in total), only the age at the moment of the first diagnosis was reported.

It was only possible to identify the localization of the lesion in 83 (40.5%) of the 205 samples, with 66 (32.3%) corresponding to samples from the maxillary sinus, followed by the sphenoidal, ethmoidal, and frontal sinuses (4.4%, 1.9%, and 1.9%, respectively). Of the total number of samples, 99 (48.3%) were positive for at least 1 of the laboratory methods. Of these 99 positive samples, 24 (24.2%) were from the maxillary sinus, followed by the sphenoidal, ethmoidal, and frontal sinuses (8.0%, 2.1%, and 2.1%, respectively). It was not possible to identify the specific sinus affected in the remaining 63.6% of samples (Table 2).

Secretions (65.9%) and biopsies (32.7%) were the most widely used clinical samples. Clinical samples taken by aspiration (1.46%) were also used. For localized infections in the ethmoidal sinus, only biopsies or secretions were assessed, while only secretions were obtained as samples from the sphenoidal sinus.

Ninety-five of 205 the samples analyzed (46.3%) were positive by direct examination. Of these, 48 (50.5%) were also positive by culture. Among the remaining 47 samples, 35 samples (49.5%) did not grow in the culture media, and 12 showed abundant bacterial contamination, thus inhibiting fungal growth. In addition, 4 samples that were negative by direct examination were positive by culture (2% of all samples). Thus, in summary, 48.3% of the 205 samples from patients with RS were positive for at least 1 of the laboratory tests.

The type of fungal structures observed by direct examination using light microscopy is shown in Table 3. Samples with positive results for both direct examination and culture are described in Table 4; in this table, a correlation is made between fungal structures observed by direct examination and the fungal agent isolated and identified from culture.

Culture was used as a gold standard to determine the sensitivity and specificity of the direct examination method. The analysis showed a sensitivity of 92.3%, a specificity of 69.3%, and positive and negative predictive values of 50.5% and 96.4%, respectively. Concordance between the direct examination and culture was 48.4% with a confidence interval of 37.4–59.4%.

The fungal agents identified in the 52 culture-positive samples are summarized in Table 5. As can be seen, 32.7% of the fungi belonged to the genus *Aspergillus*, *A. flavus* and *A. fumigatus* being the major pathogens detected in samples from patients with RS; next in importance was *Schizophyllum commune*, present in 28.8% of cases. Microorganisms such as *Candida albicans* and molds belonging to the phylum Basidiomycetes were also identified at much lower frequencies of 5.8% each. Other microorganisms belonging to the genera *Fusarium*, *Curvularia*, *Exophiala*, and *Rhizopus* as well as species such as *Scedosporium apiospermum* and *Histoplasma capsulatum* were also found.

Table 1

Distribution of patients with clinically suspected RS according to age (n = 174).

Age (years)	n (%)
<15	21 (12.1)
15–25	9 (5.2)
26–45	65 (37.4)
46–60	47 (27.0)
>60	30 (17.2)
ND	2 (1.1)
Total	174

ND = no data.

Table 2

Localization of lesions from which samples were obtained from patients with clinically suspected RS.

Infected sinus	n (%), include all analyzed samples	n (%), samples where fungi were observed or isolated
Maxillary	66 (32.3)	24 (24.2)
Sphenoidal	9 (4.4)	8 (8.0)
Ethmoidal	4 (1.9)	2 (2.1)
Frontal	4 (1.9)	2 (2.1)
ND	122 (59.5)	63 (63.6)
Total	205 (100)	99 (100)

ND = no data. Samples obtained from sinus in which localization was not specified.

4. Discussion

FRS has increased in recent years, as has the diversity of etiologic agents that cause it. FRS must be differentiated from other forms of RS, and it is important to make a correct diagnosis in order to implement an appropriate treatment for patients with this mycosis (Granville et al., 2004). Nonetheless, it is important to mention that, in immunocompetent patients, the usefulness of antifungal therapy is controversial since the primary problem in many of these cases is allergic rhinitis and symptoms often resolve with treatment of the underlying allergic rhinitis.

The immune status of the patient plays an important role in the development of this fungal disease, immunocompromised patients mainly showing aggressive infections; by contrast, immunocompetent individuals tend to present benign disease, manifested as colonizations or fungal balls (Chanqueo et al., 2009). Unfortunately, one of the limitations of the present study was that the information related to the immune status of patients in the database provided was limited and, in some cases, absent. This information was, therefore, not included in the analysis.

Some reports indicate that the most common fungal agents producing FRS are *A. fumigatus* and *C. albicans* and, to lesser extent, fungi belonging to the order Mucorales (Vergara and Hernández, 2007). The results of the present study showed that *Aspergillus* species were the most frequently isolated from clinical samples (corresponding to 32.7% of cases), *A. flavus* and *A. fumigatus* being the main pathogens isolated; these species have recently been considered as emergent pathogens and reported as causative agents of RS (Krishnan et al., 2009), with fungi such as *Candida albicans*, *Fusarium* spp., *Curvularia* spp., *Exophiala* spp., *Rhizopus* spp., *Scedosporium apiospermum*, and *Histoplasma capsulatum* identified at lower frequencies.

It is important to note that fungi such as *Curvularia* spp. and *Scedosporium apiospermum* have also been isolated from some FRS cases reported in the literature; interestingly, the patients infected with these uncommon fungi did not have any immunodeficiency (Alvarez et al., 2011). The fungus *S. apiospermum* is considered to be an

Table 3

Type of fungal structures observed by direct examination (n = 95).

Structure	n (%)
Hyaline septate hyphae	62 (65.3)
Dichotomous type <i>Aspergillus</i> hyphae	13 (13.7)
Hyaline septate hyphae and heads of <i>Aspergillus</i>	5 (5.3)
Aseptate hyphae	3 (3.2)
Hyaline septate hyphae and dematiaceous	2 (2.1)
Dematiaceous septate hyphae	2 (2.1)
Blastoconidia	2 (2.1)
Type <i>Candida</i> blastoconidia	1 (1.0)
Blastoconidia with hyphae or pseudohyphae	1 (1.0)
Small blastoconidia (Wright: intracellular and extracellular blastoconidia compatible with <i>Histoplasma</i>)	1 (1.0)
Aseptate hyphae compatible with zygomycetes	1 (1.0)
Hyphae or pseudohyphae	1 (1.0)
Filaments compatible with actinomycetes	1 (1.0)
Total	95 (100)

Table 4

Type of fungal structures observed by direct examination and their correlation with the fungal agent isolated by culture (n = 48).

Structures observed for direct examination	n (%)	Isolation by culture	n (%)
Hyaline septate hyphae	31 (64.6)	<i>Schizophyllum commune</i>	13 (27.1)
		<i>Aspergillus flavus</i>	5 (10.4)
		Basidiomycetes	3 (6.2)
		<i>Aspergillus fumigatus</i>	3 (6.2)
		<i>Aspergillus niger</i>	1 (2.1)
		<i>Aspergillus restrictus</i>	1 (2.1)
		<i>Curvularia</i> spp.	1 (2.1)
		<i>Lichtheimia</i> spp.	1 (2.1)
		<i>Scedosporium apiospermum</i>	1 (2.1)
		<i>Candida albicans</i> and <i>Fusarium</i> spp.	1 (2.1)
		Dematiaceous mold ^a	1 (2.1)
Dichotomous-type <i>Aspergillus</i> hyphae	6 (12.5)	<i>Aspergillus fumigatus</i>	2 (4.1)
		<i>Aspergillus</i> spp.	1 (2.1)
		<i>Fusarium</i> spp.	1 (2.1)
		<i>Exophiala</i> spp.	1 (2.1)
		<i>Candida albicans</i>	1 (2.1)
Aseptate hyphae	3 (6.2)	<i>Rhizopus</i> spp.	2 (4.1)
		<i>Curvularia</i> spp.	1 (2.1)
Hyaline septate hyphae and heads of <i>Aspergillus</i>	3 (6.2)	<i>Aspergillus flavus</i>	2 (4.1)
		<i>Aspergillus fumigatus</i>	1 (2.1)
Septate hyphae	1 (2.1)	<i>Schizophyllum commune</i>	1 (2.1)
Dichotomous septate hyphae	1 (2.1)	Dematiaceous mold ^a	1 (2.1)
Blastoconidia with hyphae or pseudohyphae	1 (2.1)	<i>Candida albicans</i>	1 (2.1)
Small blastoconidia (Wright: Intra and extracellular blastoconidia compatible with <i>Histoplasma</i>)	1 (2.1)	<i>Histoplasma capsulatum</i>	1 (2.1)
Hyaline septate hyphae and dematiaceous	1 (2.1)		
Total	48	<i>Pseudallescheria boydii</i>	1 (2.1)
			48 (100)

^a Not classified.

opportunistic pathogen, while *Curvularia* is the etiological agent most frequently described as the causative agent of allergic FRS or noninvasive FRS (Chanqueo et al., 2009). In this report, *Curvularia* spp. was the microorganism isolated least commonly. The high frequency of *S. commune* was particularly noteworthy, this fungus being isolated from 28.8% of the cases. *S. commune* is a mold of the phylum Basidiomycota and has a worldwide distribution, growing on timber or wood residues (Premamalini et al., 2011). It is not commonly reported as a pathogen or considered to be clinically important; in most cases, it grows concomitantly with bacteria in cultures and may thus indicate a bacterial coinfection and a subsequent requirement for antibacterial treatment (Premamalini et al., 2011; Won et al., 2012). The case of an immunocompetent Colombian patient with RS caused by *S. commune* was described in a recent report (Castro et al., 2010). The higher frequency of isolation of this fungus in the present study indicates that

S. commune should be considered as an important causative pathogen of FRS.

Other studies have reported that 10–13% of patients suffering CRS are infected by fungi and 13–28% had the maxillary sinus compromised (Chanqueo et al., 2009), equivalent to 80% of cases of FRS (Chanqueo et al., 2009; López-Vázquez et al., 2012; Maltrana et al., 2004; Vélez and Rosso-Suárez, 2012; Yáñez-García et al., 2003). In the present study, it was observed that 24% of clinical samples that were positive for fungal infection/colonization involved the maxillary sinus.

Mixed infections with *Aspergillus* and Mucorales have been described in patients with FRS and are considered to be the most pathogenic of agents (Montone et al., 2012; Ponikau et al., 1999; Zhao et al., 2011); it is noteworthy that they were identified by molecular techniques (mainly DNA amplification by PCR), suggesting the need to use other methodologies to identify the causative agents of this mycosis to species level (Zhao et al., 2011). It is thus important to know what fungal species is involved to ensure that a proper and effective antifungal treatment can be administered. It is interesting that, in this report, we found an immunocompetent female patient with recurrent CRS who presented a mixed colonization in samples obtained at different times; *A. flavus*, *S. commune*, *C. albicans*, a dematiaceous mold, and a Basidiomycetes mold were all isolated from the maxillary and sphenoidal sinuses of this patient. However, the clinical and epidemiological implications of this finding are unclear.

As mentioned above, diagnosis of FRS is difficult (Chakrabarti et al., 2009; Crisci, 2010; Granville et al., 2004; Maltrana et al., 2004), and there are currently no standardized, reproducible techniques. Clinical and physical examinations are inconclusive (Vergara et al., 2005), and there are several reports indicating a low correlation between clinical criteria and endoscopic or imaging findings (Vergara et al., 2005). Culture remains the indispensable technique for suspected fungal infection, although its sensitivity may not exceed 50% (Zhao et al., 2011). Sensitivity of 32% and specificity of 94% have been described for direct examination, with positive and negative predictive values of 81.3% and 63%, respectively (Pulido Murillo and Gaona Hernández, 2007). By contrast, based on data analyzed in the present study, direct examination had a sensitivity of 92.3% and specificity of 69.3%, with positive and negative

Table 5

Identification and frequency of fungal agents isolated by culture of samples from patients with clinically suspected RS (n = 52).

Fungal isolate	n (%)
Genus <i>Aspergillus</i>	17 (32.7)
<i>A. flavus</i>	7 (13.5)
<i>A. fumigatus</i>	7 (13.5)
<i>A. niger</i>	1 (1.9)
<i>A. restrictus</i>	1 (1.9)
<i>A. spp.</i>	1 (1.9)
<i>Schizophyllum commune</i>	15 (28.8)
<i>Candida albicans</i>	4 (7.7)
Basidiomycetes	3 (5.8)
<i>Fusarium</i> spp.	2 (3.8)
<i>Curvularia</i> spp.	2 (3.8)
<i>Rhizopus</i> spp.	2 (3.8)
Dematiaceous mold	2 (3.8)
<i>Lichtheimia</i> spp.	1 (1.9)
<i>Histoplasma capsulatum</i>	1 (1.9)
<i>Exophiala</i> spp.	1 (1.9)
<i>Pseudallescheria boydii</i>	1 (1.9)
<i>Scedosporium apiospermum</i>	1 (1.9)
Total	52 (100)

predictive values of 50.5% and 96.4%, respectively, to detect fungal structures; concordance between direct examination and culture was determined as having a value of 48.4%. These differences could be attributed to the experience of the observer, the quality and type of sample analyzed, and/or the pathogens involved, among other factors.

Given the scarcity of data about FRS in Colombia, this study represents an initial step toward understanding the frequency and importance of this mycosis in the country. Further studies are needed to address variables such as the immune status of the patient and/or underlying diseases, to determine which is the most common fungal agent in these patients, and to establish whether these conditions are determinants for acquiring the mycosis.

Conflict of interest

The authors declare that there are no conflicts of interest.

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