Clinical, radiological, and histopathological patterns of allergic fungal sinusitis: a single center retrospective study

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April 30, 2022

Abstract

Objectives: Allergic fungal rhinosinusitis (AFRS) has unique clinical symptoms, radiology, and histopathological patterns. It is easy to be misdiagnosed because of the low detection rate of fungi. The purpose of this study was to improve the diagnostic rate by analyzing these data of the clinical, radiology and pathological of AFRS. Methods: The data of patients with chronic rhinosinusitis (CRS) treated in the Department of Otolaryngology-Head and neck surgery of the First Affiliated Hospital of University of Science and technology of China (USTC) from January 2015 to December 2020 were analyzed. The discharged patients diagnosed with AFRS and the suspected cases in the description of radiology or surgical records were reviewed, combined with specific immunoglobulin E (IgE) examination, they were divided into three groups: AFRS, suspected AFRS and fungal ball sinusitis (FBS). The age, gender, eosinophils and basophils in peripheral blood, total serum IgE, invasion of sinuses, bone erosion, computed tomographic (CT) Lund-Mackay score, whether accompanied with allergic rhinitis, asthma, and olfactory hypothyroidism were all analyzed. Results: 631 patients with non-invasive fungal sinusitis were treated in the past 6 years. 29 cases of AFRS, 69 cases of suspected AFRS and 533 cases of FBS. A total of 98 confirmed and suspected AFRS cases were identified, with an average age of 34.3 years. 79 cases of multiple paranasal sinus invasion and 55 cases of bilateral paranasal sinuses. 25 cases with bone erosion. There were no significant differences in age, eosinophils percentage, basophils percentage, total serum IgE, CT Lund-Mackay score, combined with allergic rhinitis, asthma and hypoolfactory between AFRS and suspected AFRS. However, significant differences were observed in the above indicators between AFRS or confirmed AFRS and FBS. Conclusion: AFRS may be misdiagnosed due to the low detection of fungi. Clinical, laboratory, radiology and histopathological need to focus on improving the detection rate of fungi in AFRS. In order to reduce the recurrence of the disease, we can consider the diagnosis of AFRS for patients with clinical, radiology and immunological characteristics consistent with AFRS but without fungal etiology

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Abstract

Objectives: The purpose of this study was to improve the diagnostic rate by analyzing the data of the clinical, radiology and pathological of Allergic fungal rhinosinusitis (AFRS).

Method: The data of patients with chronic sinusitis (CRS) treated in our center from January 2015 to December 2020 were analyzed. The discharged patients diagnosed with AFRS and the suspected cases in the description of radiology or surgical records were reviewed, combined with specific immunoglobulin E (IgE) examination, they were divided into three groups: AFRS, suspected AFRS and fungal ball sinusitis (FBS). The participants' demographic, laboratory data and clinical characteristics were all analyzed.

Results: 631 patients with non-invasive fungal sinusitis were treated in the past 6 years. 29 cases of AFRS, 69 cases of suspected AFRS and 533 cases of FBS. A total of 98 confirmed and suspected AFRS cases were identified, with an average age of 34.3 years, 25 cases with bone erosion. The significant differences were

observed in age, eosinophils or basophils percentage, total serum IgE, CT Lund-Mackay score, combined with allergic rhinitis, asthma and hypoolfactory between AFRS or confirmed AFRS and FBS, but no differences between AFRS and suspected AFRS.

Conclusion: AFRS may be misdiagnosed due to the low detection of fungi. In order to reduce the recurrence of the disease, we can consider the diagnosis of AFRS for patients with clinical, radiology and immunological characteristics consistent with AFRS but without fungal etiology.

Key points

* Allergic fungal rhinosinusitis (AFRS) has clinical characteristics that are obviously different from chronic rhinosinusitis (CRS), with high recurrence rate and refractory, which is characterized by the presence of eosinophilic mucin with non-invasive fungal hyphae.

* The low detection rate of fungi leads to misdiagnosis of AFRS, resulting in non-standard treatment.

* There were more CRS patients with similar clinical manifestations in AFRS, but they couldn't diagnosed as AFRS because of lack of etiological evidence.

* AFRS may lead to serious complications, including loss of smell, loss of vision, blindness, cranial nerve lesions, intracranial abscess or cavernous sinus syndrome.

* Patients with characteristics of clinical, radiology and immunological characteristics consistent with AFRS but without fungal etiology, Shall be treated according to the treatment principles of AFRS.

Introduction

AFRS is non-invasive fungal sinusitis recognized in 1976[1], which is a subset of polypoid CRS that is characterized by the presence of eosinophilic mucin with non-invasive fungal hyphae within the sinuses and a type I hypersensitivity to fungi. In 1993, Bent and Kuhn proposed the diagnostic criteria of AFRS based on the prospective study of 15 patients [2]. These major criteria consist of the following: 1. Nasal polyposis; 2. Fungi on staining; 3. Eosinophilic mucin without fungal invasion into sinus tissue; 4. Type I hypersensitivity to fungi and; 5. Characteristic radiology findings with soft tissue differential densities on CT scanning and unilaterality or anatomically discrete sinus involvement. The minor criteria include bone erosion, Charcot Leyden Crystals, unilateral disease, peripheral eosinophilia, positive fungal culture and the absence of immunodeficiency or diabetes [3]. The European position paper on rhinosinusitis and nasal polyps (EPOS) 2020 steering group discussed whether the term 'eosinophilic fungal rhinosinusitis' would be a better umbrella term but it was agreed that 'allergic fungal rhinosinusitis' should be retained as the principal term due to common usage, recognizing that not all cases have evidence of an allergic reaction to fungi [4].

AFRS has a high recurrence rate. It often requires two or more surgical treatments, but it is still difficult to achieve a satisfactory therapeutic effec[5, 6]. Delays in misdiagnosis may even lead to serious complications, including loss of smell, loss of vision, blindness, cranial nerve lesions, intracranial abscess or cavernous sinus syndrome [7-12]. In serious cases, fungi may even turn into an invasive infection, resulting in patient death[11]. In order to investigate the incidence and improve the understanding of AFRS, we reread discharge and operative records, radiographic imaging, laboratory and pathological reports of CRS patients treated in our center from January 2015 to December 2020.

Materials and methods

Our research had been reviewed by the ethics committee of our hospital before initiating this retrospective study; the present work was produced in conjunction with the STROBE guidelines for reporting on cohort studies.The medical record information management system was used to record 'sinusitis' as the keyword to search for discharge diagnosis. All patients treated at our center were collected between January 2015 and December 2020. Read the patient's discharge records and operation records. When the case was diagnosed as FBS, AFRS or with allergic mucin described in the operation records, we re-read the data of radiographic imaging, laboratory, and pathological section, and re-diagnose according to Bent-Kuhn diagnostic criteria[2].

All cases were divided into three groups: A for AFRS: The patients were diagnosed according to Bent-Kuhn diagnostic criteria. B for suspect AFRS: The characteristics of clinical, radiology and allergic mucin were in accordance with the Bent-Kuhn criteria, and fungal specific IgE was positive, but no fungal evidence. C for FBS: Fungus ball infection clinical manifestation, typical radiology, the description of fungus lump in surgical records, and the fungal examination in histopathological sections were positive.

The data of three groups were collected, including gender, age, number of recurrences, side and number of sinus, bone erosion, the peripheral blood eosinophils and basophils percentage, galactomannan test, serum total IgE, pathological findings of fungi, and whether conbain with allergic rhinitis, asthma, or olfactory hypothyroidism. The difference in the above items between group A and group B, group A and group C, and group B and group C were compared.

Statistical analyses

Statistical analysis was performed with the Statistical Package for Social Sciences version 19.0 for Windows (IBM Corp., Armonk, NY). The prevalence of AFRS was calculated as the percentage of patients diagnosed and treated as AFRS among all cases of CRS treated in the same period; the result was presented as a percentage with a 95% confidence interval. Categorical variables are presented as frequency and percentage, while continuous variables are presented as mean ± standard deviation (SD). The quantitative variables were analyzed by the t-test, and the data not normally distributed were analyzed by the Kruskal Wallis.The ratio were tested by the chi square test. The Mann Whitney test and chi square test were used for multiple comparisons of quantitative and ratio. The p value was corrected by Bonferroni. A p -value of <0.05 was considered to reject the null hypothesis.

Results

A total of 2,874 patients underwent endoscopic sinus surgery, including 631 cases of non-invasive fungal sinusitis. 29 patients were re-diagnosed with AFRS, with a mean age of 33.5 (range, 13-53) years, and the median age was 35 years. 69 cases were re-diagnosed with suspect AFRS, with a mean age of 35.4 (range, 12-67) years, and the median age was 34 years. In addition, 533 cases were re-diagnosed with FBS, with a mean age of 53.9 (range, 17-85) years, and the median age was 54 years. There was no significant difference in gender composition among the three groups (p = 0.316). According to the radiology of all patients, the lesions in AFRS and suspect AFRS mostly involved bilateral sinuses and multiple sinuses. The CT Lund Mackay score of the two groups was significantly higher than that in FBS ($p < 0.001$). Furthermore, there was more bone erosion in AFRS and suspect AFRS, and the proportion of secondary and multiple operations were higher in these two groups than FBS, in which the maximum number of recurrence was five (Table 1).

Compared with AFRS and suspect AFRS, there was no significant difference in age, eosinophils percentage, basophils percentage, galactomannan test positive rate, serum total IgE, recurrence times, and the proportion of allergic rhinitis, asthma and olfactory decline ($p > 0.05$). However, significant differences were observed in the above indexes between group A and group C, and between group B and group C. Besides age, we also found that there were more cases of blood eosinophils increase in group A (9, 31.0%) and group B (28, 40.6%), which was significantly higher than that in group C (8, 1.5%, $p< 0.01$). Peripheral basophilic granulocytosis was also observed in group A (4, 13.8%) and group B (15, 21.7%). In addition, the galactomannan test, serum total IgE, recurrence times, the proportion of allergic rhinitis or asthma and the proportion of hypoolfactory in group A and group B were higher than those in group C (p < 0.01) (Table 2).

Discussion

AFRS develops in immunocompetent patients, with occurrence influenced by climate, geography, and several identified host factors.AFRS mostly occurs in men aged 21-33 years, which is significantly younger than that of CRSsNP and non-fungal CRSwNP [13, 14]. It can also occur in women and children, and AFRS in children is more invasive and prone to serious complications [15]. However, there is a lack of multicenter research on the epidemiology of AFRS in our country. In this study, the average age of group A was 33.5 years and group B was 35.4 years, which were significantly lower than 53.9 years in group C(p ¡0.001).

The confirmed cases of AFRS in our center account for 1% of CRS, which is lower than the reported 5%-10% prevalence rate [4, 16, 17]. Based on extensive reports, the prevalence of AFRS is greatly influenced by geographical location and climatic conditions. In the South American States, the prevalence of AFRS can account for 10% -23% of CRS [18]. In Japan, the prevalence of AFRS accounts for 1.4%-3.9% of CRS, and the northern region is significantly lower than the southern [19]. In Serbia, where the average temperature is lower, the prevalence of AFRS accounts for 1.3% of CRS[20]. Anhui Province is divided into a north-south climate by the Huaihe River. The north of the Huaihe River belongs to a warm temperate semi-humid monsoon climate, and the south belongs to a subtropical humid monsoon climate, and the average temperature is higher than that in Japan. Is it possible that this climatic condition may cause the prevalence of AFRS to be higher than 1%? In our study, suspected AFRS accounted for 3.41% of CRS. We hypothesized whether the low detection rate of fungi in suspected cases led to the missed diagnosis of AFRS. This conjecture is worthy of our multicenter system research.

AFRS is mostly unilateral paranasal sinuses, and 30.8% of cases are found to be delayed on the contralateral side [21]. However, patients with AFRS are often diagnosed late, at an advanced disease stage, resulting in the progress of the disease. Salamah reported that AFRS involved all four sinuses in 69.6% of patients and was bilateral in >53.5% of infected sinuses, of which maxillary sinus and ethmoid sinus were most involved. CT radiological imaging showed sinus expansion (35.3%-51.2%), remodeling (20.6%-37.2%), and wall thinning (41.2%-58.1%) [22]. This is similar to our A group cases. In our study, the prevalence of bilateral sinuses accounted for 58.6% of all cases in group A, and the involvement of two or more sinuses was as high as 89.7%, of which the patients with maxillary sinus were the most, accounting for 96.6%, followed by ethmoid sinus 72.4%, frontal sinus 51.7.0% and sphenoid sinus 48.3%. Group B and group C also showed the most involvement of maxillary sinus. However, ethmoid, frontal and sphenoid sinus showed more involvement in group A and group B (Table 1). Statistical analysis showed that there was no significant difference in the number of invaded sinuses and CT Lund-Mackay score between group A and group B ($p > 0.1$). Besides, we also found bone erosion in the cases, which were 27.6% in group A and 24.6% in group B, but rarely in group C. Bone erosion in AFRS is a mostly reversible process. Complete bone regeneration occurred in more than two-thirds of patients within a short period of time. In addition, the rate of bone regeneration was not affected by the patients' sex or age, there was no difference in the rate of bone regeneration between pediatric and adult patients[23]. AFRS is a non-invasive fungal sinusitis, and the process of bone erosion is usually attributed to pressure atrophy and inflammatory mediators induced by the accumulated fungal debris. However, paranasal sinus mucosa and periosteum are usually intact. This may suggest that bone erosion can regenerate after the compression of allergic mucin and inflammatory stimulation are relieved. Therefore, for AFRS patients with orbital and skull base bone resorption, we should pay attention to the mucoperiosteal protection of bone defect during nasal endoscopic sinus surgery.

AFRS is a type 2 immune response, characterized by antifungal IgE sensitivity, eosinophil-rich mucus (ie, allergic mucin), and characteristic CT and magnetic resonance imaging findings in paranasal sinuses [24]. Generally, AFRS has a high relapse rate, often requiring repeated or multiple operations, and is still difficult to achieve satisfactorily. Younis and Ahmed retrospectively analyzed 117 patients identified over a 5-year period with the diagnosis of AFRS or EMCRS. Twenty-six of 117 (22%) of the study patients underwent revision surgery. Within the 2-year follow-up period, an additional 5 of 26 (19%) required another revision surgery. Another study included 651 patients with CRSwNP and 45 patients with AFRS, A total of 396 (57%) patients with CRSwNPs/AFRS reported having undergone previous endoscopic nasal polypectomy, of which 182 of the 396 (46%) reported having received more than one operation. Among that, the multiple revision rate of AFRS patients was as high as 58%. The mean number of previous surgeries per patient in the revision group was 3.3 (range 2-30)[6]. In our study, the proportion of two or more surgical revisions was 34.5% in group A and 42.0% in group B, which was much higher than 6.4% in group C. This high recurrence rate often indicates that the disease has not been well controlled. Such patients often have uncontrollable symptoms of allergic rhinitis or asthma and may have decreased or even lost sense of smell. We found that 51.7% of patients in group A had decreased sense of smell, 55.2% had allergic rhinitis, and 13.8% had obvious asthma symptoms, which was significantly higher than that in group C (p ¡0.001). Hence, in the treatment

of AFRS, we still need to pay attention to the control of complications.

Statistics showed that there were significant differences between AFRS and FBS in the age, eosinophils and basophils in peripheral blood, positive rate of galactomannan test, total serum IgE, the number of relapses, proportion of allergic rhinitis, asthma, or olfactory decline in our study ($p < 0.01$). The significant differences were observed in the above indexes between group B and group C ($p < 0.01$). Another research also pointed out that eosinophils and basophils in peripheral blood were significantly increased in AFRS, and statistical analysis found significantly higher blood eosinophils and basophils levels in AFRS patients who relapsed than in those who did not[25]. In addition, no significant difference was observed between group A and group B ($p > 0.05$), which may suggest that there are some similarities between them. Unfortunately, according to Bent-Kuhn's diagnostic criteria, 69 cases could not be diagnosed as AFRS because of no fungal etiological evidence.

The definition and diagnostic criteria of AFRS are still under debate, and minor progress has been made in the last two decades to achieve a consensus. The most widely used is the Bent-Kuhn criteria. According to each author's clinical experience and the available literature, different lists of criteria are proposed. These criteria included the characteristic eosinophilic mucin containing hyphae, along with a positive fungal strain or culture, in the absence of tissue invasion by fungi, in addition to other suggestive clinical and biological evidence of an allergy such as positive atopic history, nasal polyposis, absence of immunodeficiency, and elevation of total or specific IgE or a positive skin test to fungal antigens[3, 22]. However, these diagnostic criteria were not constantly reported in the literature. The strict application of the aforementioned criteria may lead to several AFRS cases going missing diagnosis. In this single-center, the low prevalence of AFRS leads us to think about two questions: 1. Is it because of the unqualified pathological specimens or the limitation of fungal detection methods that affect our diagnosis of AFRS? 2. Whether the prevalence of AFRS in our center is lower than the real prevalence in this area due to the low detection rate of fungi. Hence, we need multi-center research for further discussion.

Conclusion

In conclusion, the low detection rate of fungi often leads to misdiagnosis of AFRS and non-standard treatment. According to the above research, we put forward the following two suggestions for clinical treatment: 1. Improve the detection rate of fungi: including standardized submission of pathological specimens, secretion fungal smears (more than 3 times) and culture, strengthen communication with pathological departments, and fully improve fungal specific examinations such as hexamine silver or Periodic Acid-Schiff staining, microwave EnVision immunohistochemistry and PCR. 2. When we encounter cases with clinical, radiology, allergic mucin and fungal specific IgE elevation that meet the Bent- Kuhn diagnostic criteria, but no fungal etiological evidence, we can consider treating them according to the principles of AFRS after excluding eosinophilic mucin sinusitis, so as to reduce the recurrence rate and reduce the incidence of complications.

References

1. Safirstein BH. Allergic bronchopulmonary aspergillosis with obstruction of the upper respiratory tract[J]. Chest, 1976, 70(6): 788-790.

2. Bent JP, 3rd and Kuhn FA. Diagnosis of allergic fungal sinusitis[J]. Otolaryngol Head Neck Surg, 1994, 111(5): 580-588.

3. deShazo RD, Swain RE. Diagnostic criteria for allergic fungal sinusitis[J]. J Allergy Clin Immunol, 1995, 96(1): 24-35.

4. Fokkens WJ, Lund VJ, Hopkins C, et al. European Position Paper on Rhinosinusitis and Nasal Polyps 2020[J]. Rhinology, 2020, 58(Suppl S29): 1-464.

5. Philpott C, Hopkins C, Erskine S, et al. The burden of revision sinonasal surgery in the UK-data from the Chronic Rhinosinusitis Epidemiology Study (CRES): a cross-sectional study[J]. BMJ Open, 2015, 5(4): e006680.

6. Younis RT, Ahmed J. Predicting revision sinus surgery in allergic fungal and eosinophilic mucin chronic rhinosinusitis[J]. Laryngoscope, 2017, 127(1): 59-63.

7. Illing EA, Dunlap Q, Woodworth BA. Outcomes of pressure-induced cranial neuropathies from allergic fungal rhinosinusitis[J]. Otolaryngol Head Neck Surg, 2015, 152(3): 541-545.

8. Holbrook JF, Eastwood JD, Kilani RK. Intracranial abscess as a complication of allergic fungal sinusitis[J]. J Neuroimaging, 2014, 24(1): 95-98.

9. O'Donnell EP and Kane AE. Permanent Unilateral Vision Loss From Allergic Fungal Sinusitis[J]. Pediatr Emerg Care, 2022, 38(1): e59-e60.

10. Kanodia A, Tandan N, Kumar R, Sagar P. Optic nerve compression due to allergic fungal rhinosinusitis[J]. BMJ Case Rep, 2020, 13(11): e238817.

11. Walter E, McKean EL, Camelo-Piragua SI, Parmar HA, Trobe JD. Catastrophic Allergic Fungal Sinusitis: A Report of Two Cases[J]. J Neuroophthalmol, 2020, 40(4): 507-513.

12. Chalam KV, Enghelberg M, Murthy RK. Allergic fungal sinusitis masquerading as cavernous sinus thrombosis[J]. J Surg Case Rep, 2020, 2020(8): rjaa233.

13. Lu-Myers Y, Deal AM, Miller JD, et al. Comparison of Socioeconomic and Demographic Factors in Patients with Chronic Rhinosinusitis and Allergic Fungal Rhinosinusitis[J]. Otolaryngol Head Neck Surg, 2015, 153(1): 137-143.

14. Wise SK, Ghegan MD, Gorham E, Schlosser RJ. Socioeconomic factors in the diagnosis of allergic fungal rhinosinusitis[J]. Otolaryngol Head Neck Surg, 2008, 138(1): 38-42.

15. Suzuki M, Connell J, Psaltis AJ. Pediatric allergic fungal rhinosinusitis: optimizing outcomes[J]. Curr Opin Otolaryngol Head Neck Surg, 2021, 29(6): 510-516.

16. Lackner A, Stammberger H, Buzina W, et al. Fungi: a normal content of human nasal mucus[J]. Am J Rhinol, 2005, 19(2): 125-129.

17. Kale P, Rudramurthy SM, Panda NK, Das A, Chakrabarti A. The inflammatory response of eosinophil-related fungal rhinosinusitis varies with inciting fungi[J]. Med Mycol, 2015, 53(4): 387-395.

18. Ferguson BJ, Barnes L, Bernstein JM, et al. Geographic variation in allergic fungal rhinosinusitis[J]. Otolaryngol Clin North Am, 2000, 33(2): 441-449.

19. Makihara S, Kariya S, Naito T, et al. Low Incidence of Allergic Fungal Rhinosinusitis in Japanese Patients[J]. Clin Med Insights Ear Nose Throat, 2019, 12: 1179550619870758.

20. Barac A, Stevanovic G, Pekmezovic M, et al. Study toward resolving the controversy over the definition of allergic fungal rhinosinusitis[J]. Med Mycol, 2018, 56(2): 162-171.

21. AlQahtani A, Alshaikh N, Alzarei A, et al. Contralateral sinus involvement of surgically treated unilateral allergic fungal rhinosinusitis[J]. Eur Arch Otorhinolaryngol, 2017, 274(8): 3097-3101.

22. Salamah MA, Alsarraj M, Alsolami N, et al. Clinical, Radiological, and Histopathological Patterns of Allergic Fungal Sinusitis: A Single-Center Retrospective Study[J]. Cureus, 2020, 12(7): e9233.

23. Alarifi I, Al-Dousary S, Bin Hazza'a A, Sumaily I. Bone Regeneration in Allergic Fungal Rhinosinusitis: Post-treatment Image Follow Up[J]. Cureus, 2019, 11(12): e6502.

24. Dykewicz MS, Rodrigues JM, Slavin RG Allergic fungal rhinosinusitis[J]. J Allergy Clin Immunol, 2018, 142(2): 341-351.

25. Brescia G, Franz L, Alessandrini L, et al. Prognostic role of blood eosinophil and basophil levels in allergic fungal rhinosinusitis (AFRS)[J]. Am J Otolaryngol, 2020, 41(1): 102301.

Table1 Participants' demographic and clinical characteristics

Parameter	Parameter	Category	Category
Gender		Male (n)	Male (n)
		Female (n)	Female (n)
Total patients (n)	Total patients (n)		
Age (year)	Age (year)	Minimum	Minimum
		Maximum	Maximum
		Below 18	Below 18
		Mean, SD	Mean, SD
Proportion	Proportion	In non-invasive fungal sinusitis (%)	In non-invasive fu
		In CRS (%)	In CRS (%)
CT radiological imaging	CT radiological imaging	CT radiological imaging	CT radiological i
Sinus invasion	Single sinus, n(%)	Single sinus, n(%)	Single sinus, n(%
	Unilateral sinus, n(%)	Unilateral sinus, n(%)	Unilateral sinus,
	Maxillary, n(%)	Maxillary, n(%)	Maxillary, n(%)
	Ethmoid, n(%)	Ethmoid, n(%)	Ethmoid, n(%)
	Frontal, n(%)	Frontal, n(%)	Frontal, n(%)
	Sphenoid, n(%)	Sphenoid, n(%)	Sphenoid, n(%)
Bone erosion	n (%)	n (%)	n (%)
CT Lund-Mackay score	CT Lund-Mackay score	CT Lund-Mackay score	Mean, SD
Endoscopic sinus surgery (ESS)	Endoscopic sinus surgery (ESS)	Endoscopic sinus surgery (ESS)	Endoscopic sinus
First	First	n (%)	n (%)
Second	Second	n (%)	n (%)
Multiple	Multiple	n (%)	n (%)

'Under 18' means the number of patients below 18 years old; 'CRS' = chronic rhinosinusitis; 'Single sinus' means the number of patients with allergic fungal sinusitis involving a single sinus, and the rest were patients with two or more sinuses involved. 'Unilateral sinus' means the number of patients with allergic fungal sinusitis involving unilateral sinus, and the others were bilateral sinuses involved. 'ESS' = endoscopic sinus surgery; 'First' means patients were treated for the first time by ESS, "Multiple" means patients were treated for the multiple times by ESS.

Table 2 Summary laboratory and clinical data

Parameter	Parameter	Parameter	
Laboratory reports	Laboratory reports		
GM test positive	GM test positive	n, %	n, %
Eosinophils	Increased (n, %)	Increased (n, %)	Increased
	Percentage (Mean,SD)	Percentage (Mean,SD)	Percenta
Basophils	Increased (n, %)	Increased (n, %)	Increased
	Percentage (Mean,SD)	Percentage (Mean,SD)	Percenta
Relapse frequency	Relapse frequency	Maximum	Maximu
		Mean,SD	Mean,SD
Total serum IgE(IU/ml, Mean, SD)	Total serum IgE(IU/ml, Mean, SD)	Total serum IgE(IU/ml, Mean, SD)	Total ser
Clinical complication	Clinical complication	Clinical complication	Clinical c
Olfactory dysfunction n (%)	Olfactory dysfunction n (%)	Olfactory dysfunction n (%)	Olfactory
Asthma	Asthma	n (%)	n (%)
Allergic rhinitis	Allergic rhinitis	n (%)	n (%)

p -value means the difference between the three groups. '**' means the difference between AFRS and FBS or between suspect AFRS and FBS was statistically significant, $p < 0.001$; '*' means the difference between AFRS and FBS or between suspect AFRS and FBS was statistically significant ($p < 0.01$).