

Concomitant allergic bronchopulmonary aspergillosis and allergic *Aspergillus* sinusitis: a review of an uncommon association*

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Summary

Background Although thought to have common immunopathological processes, concomitant occurrence of allergic bronchopulmonary aspergillosis (ABPA) and allergic *Aspergillus* sinusitis (AAS) appears to be rarely reported as to date only five detailed case reports are available.

Objective To present a review of seven cases of concomitant ABPA and AAS, three of whom were earlier reported for their unusual presentations.

Methods Patients with ABPA with nasal symptoms were evaluated radiologically. Consent was taken for antral wash and/or Caldwell-Luc operation in those with radiological evidence of sinusitis and the material was sent for histopathological and mycological studies.

Results Of the 95 patients with ABPA, 22 had radiological evidence of sinusitis. Nine consented to surgery, seven of whom were diagnosed as concomitant AAS. Nasal symptoms preceded chest symptoms in two patients, vice versa in one and occurred simultaneously in four. Familial occurrence of ABPA, middle lobe syndrome and collapse with effusion along with an operated aspergilloma were seen in one patient each. Transient pulmonary infiltrates and central bronchiectasis were seen in all patients. Computed tomography of the paranasal sinuses, carried out in six patients, revealed mucosal thickening with hyperdense lesions, without any bony erosion or destruction. All patients had positive skin tests, positive precipitin study and raised total and specific IgE. Allergic mucin was seen in all patients, fungal hyphae in five, and culture grew *Aspergillus* spp. in four. All patients responded favourably to oral prednisolone.

Conclusion Concomitant occurrence of ABPA and AAS seems to be infrequently recognized. Since asthma and sinusitis are often seen by two different specialities, the occurrence of AAS in ABPA and ABPA in AAS may easily be overlooked.

Keywords: allergic *Aspergillus* sinusitis, allergic bronchopulmonary aspergillosis, allergic bronchopulmonary mycoses, allergic fungal sinusitis, concomitant occurrence

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Introduction

The spectrum of *Aspergillus*-associated respiratory disorders can broadly be classified into three main clinical categories: allergic aspergillosis, aspergilloma and invasive aspergillosis [1]. Allergic bronchopulmonary aspergillosis (ABPA), the most frequently recognized manifestation of

allergic aspergillosis, is not uncommon in India [2]. This category also includes allergic *Aspergillus sinusitis* (AAS), a more recently described clinicopathological entity in which mucoid impaction akin to that of ABPA occurs in the paranasal sinuses [3]. Although both ABPA and AAS are categorized together and have histopathological similarities, these two clinical entities appear to remain mutually exclusive. Concomitant occurrence of ABPA and AAS appears to be rarely reported as to date only five detailed case reports [4–8] have been published, while mention has been made of four more patients, without details, in two series of allergic fungal sinusitis (AFS) [9,10]. In addition, allergic bronchopulmonary mycoses (ABPM) with concurrent AFS has been reported in four other patients [11,12], out of which only two were elaborated upon [11].

Because of the rarity of their presentation, we had previously reported three patients with concomitant disease [5,7,8]. In addition to these three patients, we describe four new patients with concomitant ABPA and AAS and present a review of seven cases.

Materials and methods

All patients who were diagnosed as ABPA in our unit were also interrogated for nasal symptoms such as rhinorrhoea, nasal block, sneezing, post-nasal drip or any history of passage of golden brown plugs/casts along with nasal secretions. A skiagram of the paranasal sinuses was also done. In those patients who had radiological evidence of involvement of one or more paranasal sinuses, consent was obtained for accessing the pathological material. Patients who consented underwent either an antral wash and/or Caldwell-Luc operation. The material obtained was sent for histopathological and mycological studies.

Diagnosis of ABPA was based on the following criteria: (i) history of asthma; (ii) history of occasional passage of brownish plugs along with sputum; (iii) transient pulmonary infiltrates; (iv) central bronchiectasis; (v) sputum culture positive for *A. fumigatus*; (vi) bands of precipitins against *A. fumigatus*; (vii) type I and type III hypersensitivity to intradermal challenge with extracts of *Aspergillus* spp. (antigens obtained from Center for Biochemical Technology, Delhi, a unit of the Council of Scientific and Industrial Research); (viii) elevated total IgE level; and (ix) elevated specific IgG or IgE against *A. fumigatus*.

The criteria adopted by us earlier [5,7,8] and subsequently enunciated by deShazo and Swain [13] were followed for diagnosis of AAS in our study: (i) sinusitis of one or more paranasal sinus on X-ray film; (ii) necrosed amorphous tissue along with oedematous polyps infiltrated with eosinophils on histopathological evaluation of material from the sinus; (iii) demonstration of fungal elements in nasal discharge or in material obtained at the time of surgery by stain or culture;

(iv) absence of diabetes, previous or subsequent immunodeficiency disease, and treatment with immuno-suppressive drugs; and (v) absence of invasive fungal disease at the time of diagnosis or subsequently.

Results

We had 95 cases of ABPA for analysis, of whom 38 had associated nasal symptoms. Of these 38 patients, the preliminary skiagram of the paranasal sinuses revealed sinus involvement in 17 patients. In addition, five asymptomatic patients also had radiological evidence of sinusitis. Of these 22 patients with radiological evidence of sinusitis, only nine patients consented to undergo surgical procedure for diagnosis. Postoperative confirmation of AAS was available in seven patients. None of these seven patients was diagnosed with ABPA prior to referral.

The clinical profile and laboratory data of these seven patients with concomitant ABPA and AAS are summarized in Tables 1 and 2. The patients are numbered as per the chronological order of presentation. There were four males aged 24, 45, 55 and 30 years and three females aged 38, 29 and 14 years. The mean duration of illness was 9.9 years (range 10 months to 37 years). In two patients, the nasal symptoms preceded the chest symptoms by 4 and 10 years (patients 1 and 3) while in patient 4, the chest symptoms appeared 32 years prior to the nasal symptoms. However, in the other four patients, the nasal and chest symptoms appeared simultaneously.

Nasal symptoms

All the seven patients had watery or mucopurulent discharge, sneezing and nasal blockade. Passage of golden brown plugs/casts along with nasal secretion was reported by four patients. Post-nasal drip was complained of by only two patients, while four patients complained of frontal headaches. Episodes of fever during exacerbation were reported by all seven patients, while none of the patients had epistaxis.

Chest symptoms

Cough and expectoration were the predominant symptoms in all the seven patients, while dyspnoea and chest pain were reported by six. Wheezing and fever during exacerbation were observed by five patients each. Passage of golden brown plugs/casts along with sputum was reported by four patients, while three had haemoptysis, one of whom had an aspergilloma lodged in a bronchiectatic cavity which was operated on [7].

Family history of atopy

A noteworthy feature was the atopic background of our patients, four of whom had a family history of asthma and/

Table 1. Clinical profile of seven patients with concomitant ABPA and AAS

No.	1	2	3	4	5	6	7
Age/sex	24/M	45/M	55/M	38/F	29/F	30/M	14/F
Duration of illness (yr)	12	10/12	12	37	5	1	1½
Nasal symptoms							
Age of onset (yr)	12	44	43	33	24	29	12½
Watery discharge	+	+	+	+	+	+	+
Mucopurulent discharge	+	+	+	+	+	+	+
Sneezing	+	+	+	+	+	+	+
Nasal block	+	+	+	+	+	+	+
Plugs/casts	+	–	+	+	+	–	–
Post-nasal drip	+	+	–	–	–	–	–
Epistaxis	–	–	–	–	–	–	–
Frontal headache	+	–	+	–	+	+	–
Fever	+	+	+	+	+	–	+
Chest symptoms							
Age of onset (yr)	18	44	53	1	24	29	12½
Cough	+	+	+	+	+	+	+
Expectoration	+	+	+	+	+	+	+
Plugs/casts	+	–	+	+	+	–	–
Wheezing	+	–	+	+	+	–	+
Dyspnoea	+	+	+	+	+	–	+
Chest pain	+	+	+	+	–	+	+
Haemoptysis	–	+	–	+	+	–	–
Fever	+	+	+	+	–	–	+
Family history							
Asthma	Father	–	–	Mother	Father	–	–
Rhinitis	Brother	–	Son	Mother	Brother	–	–
ABPA	Mother	–	–	–	–	–	–
Past treatment							
Antibiotics	+	+	+	+	+	+	+
Decongestants	+	+	+	+	+	+	+
Antituberculous therapy	–	+	+	–	+	+	+
Septoplasty	+	–	+	–	–	–	–
Cryoprobe	+	–	–	–	–	–	–
Polypectomy	+	–	–	+	+	+	–
Immunotherapy	+	–	–	–	–	–	–
Physical examination							
Mucopurulent discharge	+	+	+	+	+	+	+
Sinus tenderness	–	–	+	+	+	+	–
Rhonchi	+	+	+	+	+	+	+
Consolidation	–	–	RML	– (LLL collapse)	–	–	RUZ, LMZ

Abbreviations used: M = male; F = female; RML = right middle lobe; LLL = left lower lobe; RUZ = right upper zone; LMZ = left middle zone.

or rhinitis. Patient 1 also had a familial history of ABPA in his mother [5].

Prior treatment

Previous history of surgical intervention for nasal symptoms in the form of septoplasty, application of cryoprobe, polypect-

omy, ethmoidectomy or Caldwell-Luc operation, was available in five out of the seven patients. However, none of these patients had any benefit from these invasive interventions. Five of them had received/were receiving anti-tuberculous treatment (ATT) when they reported to us. All these patients had also received antibiotics and decongestants off and on, while patient 1 had received immunotherapy without any benefit.

Table 2. Laboratory data of seven patients with concomitant ABPA and AAS

S. No.	1	2	3	4	5	6	7
Blood							
TLC (cells/mm ³)	9300	8900	7700	9300	9400	11 800	14 400
Eosinophil percentage	9	3	26	24	16	8	11
Sputum							
AFB smear	—	—	—	—	—	—	—
Pyogenic culture	—	—	—	—	—	—	—
Fungal culture	A.f. + A.fl	A.f.	—	—	—	A.f.,A.fl.,A. n.	—
Nasal discharge							
Fungal culture	A.fl.	—	—	—	—	—	—
X-ray chest	TPI	TPI	TPI	TPI (L), lung collapse with pleural effusion	TPI	TPI	TPI
			Middle lobe syndrome				consolidation RUZ + LMZ
X-ray PNS	(R) max. sinusitis	b/l max. sinusitis (L > R)	b/l max. sinusitis	b/l max. sinusitis	b/l max. + frontal sinusitis	b/l max. + frontal sinusitis	b/l max. sinusitis
Spirometry							
FVC (L/mt)	4.58	3.52	3.11	3.24	3.45	2.1	1.55
FEV ₁ /FVC(%)	59	60	63	58	76	79	72
Skin test							
Type I	++	++	++	++	++	++	++
Type III	++	++	++	++	++	++	++
Serum precipitins							
<i>A. fumigatus</i>	+	+	+	+	+	+	+
<i>A. flavus</i>	++	+	+	+	+	+	+
<i>A. niger</i>	—	—	—	—	—	+	—
Total IgE (IU/mL)	5600	680	540	280	590	4560	25216
Aspergillus spp. IgE/IgG	+	+	+	+	+	+	+
Sinus wash/biopsy							
Necrosis	+	+	+	+	+	+	+
Eosinophil infiltrate	+	+	+	+	+	+	+
Charcot-Leyden crystals	+	—	+	+	+	—	+
Fungal elements	+	—	+	+	—	+	+
Fungal culture	A.fl.	A.f.	A.f.	—	A.n.	—	—
CT-thorax	ND	CB	CB	CB	CB	CB	CB
Bronchography	CB	CB	CB	ND	ND	ND	ND
CT-PNS	+	ND	+	+	+	+	+

TLC = total leucocytic count; AFB = acid fast bacilli; A.f. = *Aspergillus fumigatus*; A.fl. = *Aspergillus flavus*; A.n. = *Aspergillus niger*; TPI = transient pulmonary infiltrates; RUZ = right upper zone; LMZ = left mid zone; max. sinusitis = maxillary sinusitis; b/l = bilateral; CT = computed tomography; ND = not done; CB = central bronchiectasis.

Physical examination

Examination of the upper respiratory tract revealed mucopurulent nasal discharge with erythematous nasal mucosa in all seven patients. Sinus tenderness was elicited in four patients and one patient (patient 7) had a marked deviated nasal septum. Chest auscultation detected polyphonic

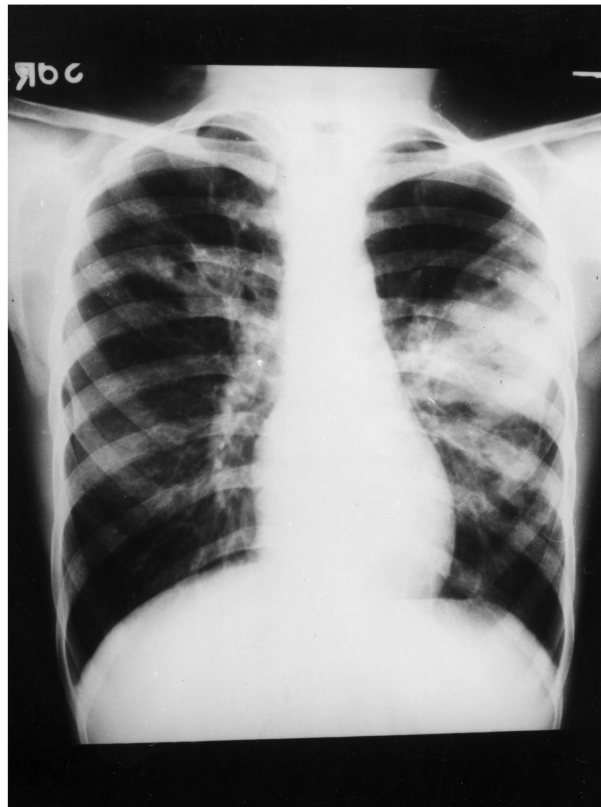
rhonchi in all patients. Evidence of consolidation was available in patients 3 and 7, while patient 4 had features suggestive of left lower lobe collapse [7].

Peripheral blood examination

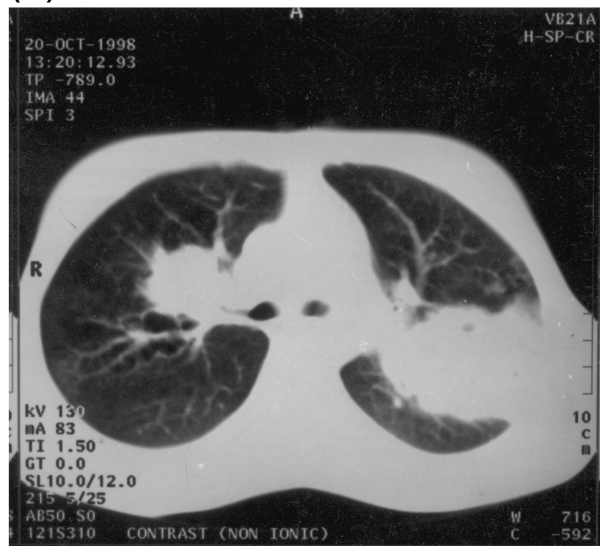
Total leucocytic count in the seven patients ranged from

7700 cells/mm³ to 14 400 cells/mm³ against a normal range of 4000–11 000 cells/mm³. Peripheral eosinophilia between 8% to 26% was observed in six patients, while in patient 2 the eosinophil count was 3%.

(a)



(b)



Sputum and nasal secretion examination

Sputum and nasal secretions of all patients were sent for culture for pathogenic fungi. *A. fumigatus* was grown from sputum samples of patients 1, 2 and 6, *A. flavus* from patients 1 and 6, and *A. niger* was also grown in addition to *A. fumigatus* and *A. flavus* from the sample from patient 6. Culture of nasal discharge grew *A. flavus* in pure culture from patient 1. Repeated sputum stains and culture were negative for *Mycobacterium tuberculosis* or any other aerobic organisms.

Radiology: chest

Review of chest roentgenograms revealed transient pulmonary infiltrates in all the seven patients. In addition, middle lobe syndrome was seen in patient 3 [8], left lung collapse with left pleural effusion in patient 4 [7] and consolidation with cavitation in the right upper zone and left mid-zone in patient 7 (Fig. 1a). Computed tomography (CT) of the thorax was performed in six patients and bronchography (BG) in three patients (Table 2). Computed tomography confirmed the roentgenologic findings in all these patients and CT (Fig. 1b) and/or BG demonstrated central bronchiectasis (CB) with normal peripheral bronchi, a *sine qua non* for the diagnosis of ABPA, in all the seven patients.

Radiology: paranasal sinuses

Roentgenogram of the paranasal sinuses (PNS) showed bilateral haziness of the maxillary sinuses (Fig. 2a) in six patients and unilateral (right sided) haziness in patient 1. Bilateral frontal sinuses were also involved in patients 5 and 6. Computed tomography (CT) of the PNS was also carried out in six patients and revealed mucosal thickening of one or more paranasal sinus with hyperdense lesions within suggesting inspissated secretions (Fig. 2b). No bony erosion or destruction was seen in any of these patients.

Spirometry

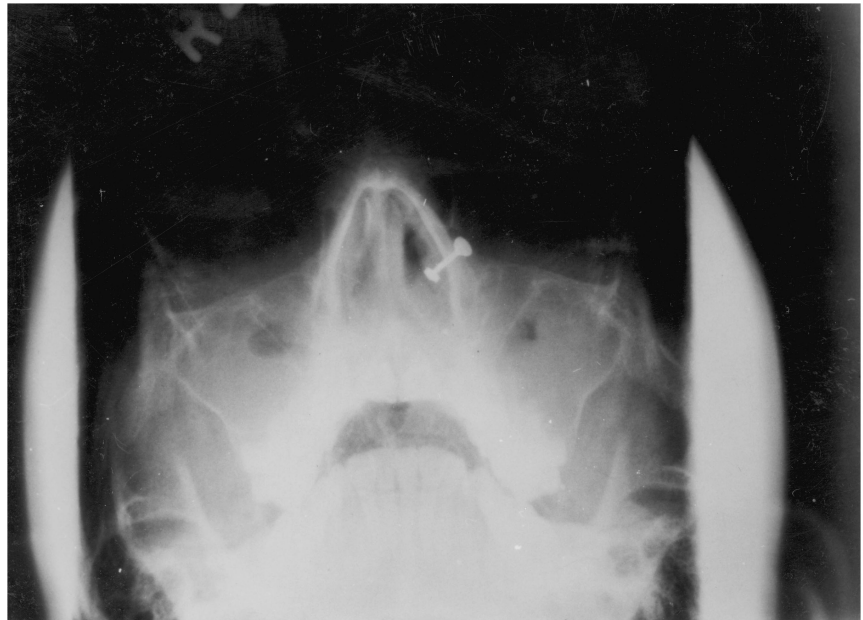
Spirometric evaluation revealed obstructive ventilatory defect in all the seven patients.

Skin test

Intradermal challenge with antigens of *A. fumigatus* and *A.*

Fig. 1. (a) Chest roentgenogram of patient 7 showing non-homogeneous consolidation predominantly in the left mid-zone and right upper zone. A cavity is also seen in the right upper zone. (b) Computed tomogram of the thorax, of the same patient, confirming a consolidation in the left upper lobe. A 'string of pearl' appearance suggestive of central bronchiectasis is also seen.

(a)



(b)

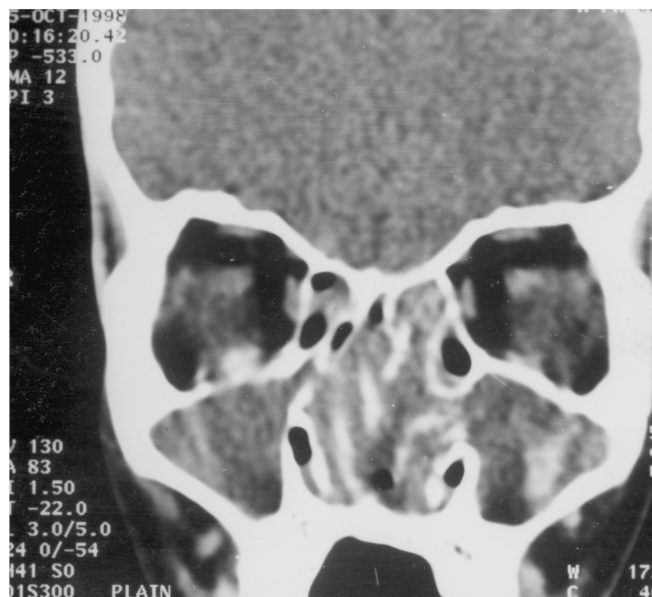


Fig. 2. (a) Roentgenogram of the paranasal sinuses of patient 7 showing haziness of both the maxillary sinuses. (b) Computed tomogram of the paranasal sinuses, of the same patient, showing soft tissue mass in both ethmoids and also in both maxillary sinuses extending into the nasal cavity. Hyperdense lesions are also visible within the soft tissue mass suggestive of inspissated secretions.

flavus elicited strong type I (immediate) and type III (delayed) hypersensitivity reactions in all the seven patients.

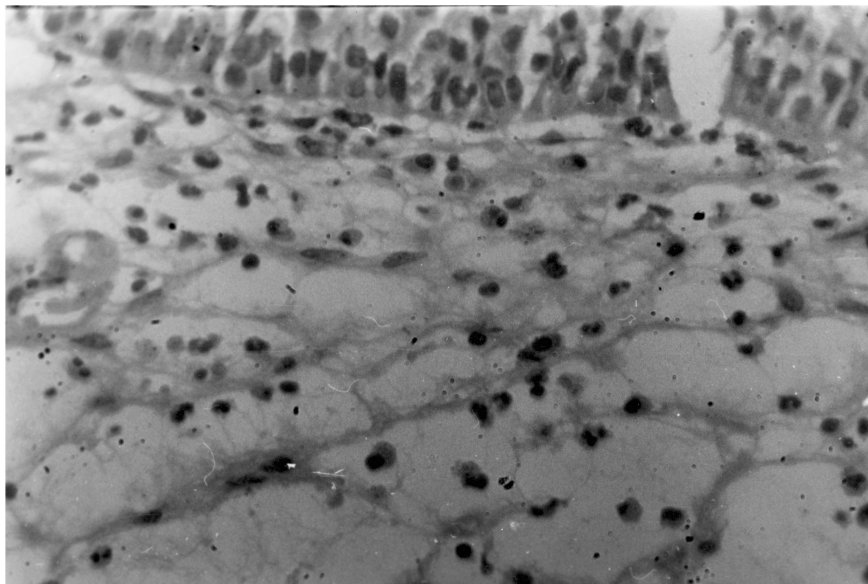
Immunological tests

Strong bands of precipitins were detected on gel-diffusion studies against antigens of both *A. fumigatus*

and *A. flavus* in all seven patients. In addition, in patient 6 precipitating antibodies were also detected against antigen of *A. niger*.

Total IgE was raised in all the seven patients compared with the reference range. The actual values are given in Table 2. *Aspergillus*-specific IgE/IgG was positive by ELISA in all the seven patients.

(a)



(b)

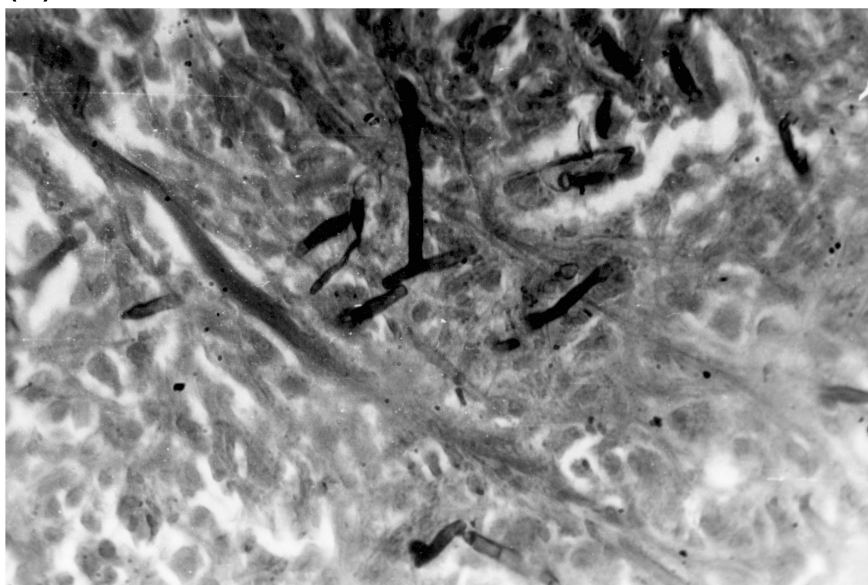


Fig. 3. (a) Photomicrograph of biopsy material from the maxillary sinus showing oedematous stroma and heavy infiltration of eosinophils. Haematoxylin and eosin stain, $\times 1200$. (b) Photomicrograph of biopsy material from the maxillary sinus showing branching septate hyphae of *Aspergillus* spp.. Gomori's methenamine silver nitrate stain, $\times 1200$.

Sinus wash/biopsy

Histological examination of the material obtained from an antral wash and/or Caldwell-Luc operation revealed inflammatory exudate with mucin, extensive coagulative necrosis, collection of eosinophils enclosing fungal hyphae in places and Charcot-Leyden crystals, similar to the mucoid impaction of ABPA (Figs 3a and b). Mycological culture of the material yielded pure growth of *A. flavus* (patient 1), *A. fumigatus* (patients 2 and 3) and *A. niger* (patient 5).

Treatment

After confirmation of diagnosis, all our patients were initially commenced on oral prednisolone in the dose of 0.5 mg/kg body weight once daily along with supportive therapy for asthma. Subsequently prednisolone was converted to an alternate day regimen. All the patients had a favourable response to therapy. Patient 1 chose to be treated by an alternate system of medicine after 2 years of therapy with prednisolone. Patients 2 and 4 were lost to

follow-up after 6 months. Patient 3 reports irregularly. Patients 5, 6 and 7 have been on prednisolone off and on for 1–3 years. In addition, these patients were also on intranasal corticosteroid sprays, but it seems that they experienced relief with oral prednisolone only.

Discussion

Although it appears that the patient with ABPA provides a favourable *milieu* for the occurrence of AAS, it is perhaps surprising that in spite of similar histopathological features the coexistence of both these diseases has not often been reported. In our review of 95 patients with ABPA, we were able to confirm the presence of concomitant AAS in only seven patients. However, we had 13 other patients with radiological evidence of sinusitis in whom the possibility of AAS could not be ruled out as they refused to undergo the invasive procedures required to establish the diagnosis. Hypothetically, the frequency of AAS among our patients with ABPA could be higher.

In a series of 44 patients with AFS from the Mayo Clinic [14], there was no mention of concomitant ABPA. deShazo and Swain [13] reviewed 106 cases of AFS, of whom 99 were previously reported (other than the Mayo Clinic series [14]) and they found only four convincing reports in which the two conditions coexisted. Subsequently, in a report of 25 patients with AFS, AAS was seen in only one patient, while associated ABPM was not recorded [15]. Recently, in a series of 67 consecutive cases of AFS predominantly caused by *Bipolaris spicifera*, concomitant AFS and ABPM were seen in only two patients [12].

A review of the literature revealed that concurrent occurrence of ABPA and AAS has been reported in nine patients only, five of whom have been reported in detail. This includes three of the seven patients reviewed in this series [5,7,8]. The other two patients were reported from Cleveland [4,6]. Three of the remaining four patients were mentioned in a review of 10 cases of AFS by one of the authors from the Cleveland group [10]. One more case of ABPA and AAS was mentioned while reporting three cases of AFS [9]. In addition, four other patients with concomitant ABPM and AFS have been reported, two of whom were attributed to *Curvularia* spp. [11]. The other two cases due to *Bipolaris* spp. mentioned in the literature were, however, not elaborated upon [12].

The occurrence of ABPA/ABPM in some asthmatic subjects is thought to be due to the tenacious secretions within the bronchi which provide a hospitable environment for the growth of fungi and subsequent release of antigenic material. This sets into motion a host of immunological reactions culminating in pulmonary damage [5]. Since pathological similarities to ABPA/ABPM are considered to be the hallmark of AAS/AFS, it is likely that a similar chain

of events may be responsible for its onset. An alternative explanation is that the changes in the bronchial or sinus mucous and the secretory immune system that favour growth of fungi may exist in bronchi as well as sinuses of patients who develop ABPA/ABPM and AAS/AFS [5]. The factors responsible for the predilection of the fungus for the sinuses in some patients and the bronchi in others remain unknown. In all our seven patients, ABPA was diagnosed first although in two of them the nasal symptoms preceded the chest symptoms and in one the chest symptoms preceded the nasal symptoms, while in the remaining four the chest and nasal symptoms appeared simultaneously. In the other two patients with ABPA and AAS for whom details were available, the first diagnosis was ABPA in the first case though sinusitis was present since childhood [4] and in the subsequent case sinusitis was the predominant disease and the first diagnosis was AAS [6]. In the two patients with ABPM and AFS due to *Curvularia* spp., AFS was the predominant presentation, although one of them had chest symptoms preceding the nasal symptoms [11].

A history of passage of both nasal and sputum plugs was elicited in four of our seven patients. McCarthy and Pepys [16], in their review of 111 patients with ABPA, reported the passage of sputum plugs in 54% and nasal plugs in 10% cases. Safirstein [17] described a patient with ABPA with obstruction of the upper respiratory tract in whom there was a history of passage of hard nasal plugs. This report, in retrospect, is thought to be a case of concomitant AAS and ABPA [17]. Schubert and Goetz [12] also reported passage of nasal casts in 75% of their 67 patients with AFS. History of passage of nasal and sputum plugs in a patient should alert the physician to the possibility of coexistent ABPA and AAS.

Radiological techniques have been crucial to the diagnosis of ABPA as well as AAS. In ABPA, not only do imaging techniques help to establish the diagnosis but they also help to monitor the progress of the disease. Demonstration of CB with normal peripheral bronchi, a pathognomic feature of ABPA, is considered a *sine qua non* for the diagnosis of this disease. Computed tomography is now considered to be an effective technique for the demonstration of CB [18,19]. Computed tomography can provide a sensitive method for the assessment of bronchial, parenchymal and pleural abnormalities in patients with ABPA [20,21]. Recently, Mukherji and colleagues [22] evaluated the CT findings in 45 patients with AFS. They recorded mucosal thickening and increased intrasinus attenuation as features consistently seen in all their patients. These two features were also seen in all our six patients in whom CT of the PNS was done. Although bony erosion was a finding in the majority of their patients, this feature was not seen in any of ours. It appears that CT-thorax and CT-PNS, along with plain skiagrams, are essential

components of the diagnostic work-up of both these diseases.

The diagnosis of AAS is principally based on pathological findings in the specimens obtained from the paranasal sinuses. These findings are characteristically similar to those seen in the mucoid impaction of ABPA that were first described by Millar et al. [23]. The term 'allergic mucin' was coined by Katzenstein *et al.* [24], to describe this material that demonstrated eosinophils, Charcot-Leyden crystals, cellular debris and scattered fungal hyphae. All these features were seen in all our seven patients. In addition, culture of the surgically obtained material from the sinus grew *Aspergillus* species in four of our seven patients.

A noteworthy feature seen in five of our patients was history of surgical procedures for nasal symptoms prior to referral. Patient 1 was subjected to three procedures without relief (Table 1). All patients had a favourable response to therapy with oral prednisolone. Although the patients were relieved of both nasal and chest symptoms with therapy, they were, however, somewhat dissatisfied as therapy involved regular oral corticosteroids and symptoms recurred on withdrawal of prednisolone. Optimal therapy for ABPA and AAS is yet to evolve. The current approach to therapy for AFS seems to indicate a combined surgical and medical approach, advocating an initial debridement to be followed with oral corticosteroids. However, there have been no systematic studies to define the benefits of the current treatment modalities.

In conclusion, our review suggests that the co-occurrence of ABPA and AAS may not be as rare as it appears. Oral corticosteroids remain the cornerstone of treatment of both diseases, suggesting that common immunopathological processes are involved. Asthma and sinusitis are two diseases often treated by two different specialities. The occurrence of AAS in ABPA and ABPA in AAS may thus be overlooked. A high index of suspicion along with early diagnosis could alter the natural history of both these diseases and reduce associated morbidity.

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References

- Greenberger PA. Allergic bronchopulmonary aspergillosis. In: Middleton E Jr, Reed CE, Ellis EF, Adkinson NF Jr, Yunginger JW, Busse WW eds. Allergy: Principles and Practice, 5th edn. St Louis: CV Mosby, 1998:981–93.
- Shah A. Allergic bronchopulmonary aspergillosis: an emerging disease in India (Editorial). Indian J Chest Dis Allied Sci 1994; 36:169–72.
- Shah A, Khan ZU, Sircar M et al. Allergic *Aspergillus* sinusitis: an Indian report. Respir Med 1990; 84:249–51.
- Sher TH, Schwartz HJ. Allergic *Aspergillus* sinusitis with concurrent allergic bronchopulmonary *Aspergillus*: report of a case. J Allergy Clin Immunol 1988; 81:844–6.
- Shah A, Khan ZU, Chaturvedi S, Bazaz Malik G, Randhawa HS. Concomitant allergic *Aspergillus* sinusitis and allergic bronchopulmonary aspergillosis associated with familial occurrence of allergic bronchopulmonary aspergillosis. Ann Allergy 1990; 64:507–12.
- Schwartz HJ, Witt WJ, Sher TH. Allergic bronchopulmonary aspergillosis and allergic *aspergillus* sinusitis: case report. Ann Allergy 1992; 69:447–8.
- Bhagat R, Shah A, Jaggi OP, Khan ZU. Concomitant allergic bronchopulmonary aspergillosis and allergic *Aspergillus* sinusitis with an operated aspergilloma. J Allergy Clin Immunol 1993; 91:1094–6.
- Shah A, Bhagat R, Panchal N, Jaggi OP, Khan ZU. Allergic bronchopulmonary aspergillosis with middle lobe syndrome and allergic *Aspergillus* sinusitis. Eur Respir J 1993; 6:917–8.
- Allphin AL, Strauss M, Abdul-Karim FW. Allergic fungal sinusitis: problems in diagnosis and treatment. Laryngoscope 1991; 101:815–20.
- Schwartz HJ. Allergic fungal sinusitis: experience in an ambulatory allergy practice. Ann Allergy Asthma Immunol 1996; 77:500–2.
- Travis WD, Kwon-Chung KJ, Kleiner DE et al. Unusual aspects of allergic bronchopulmonary fungal disease: report of two cases due to *Curvularia* organisms associated with allergic fungal sinusitis. Hum Pathol 1991; 22:1240–8.
- Schubert MS, Goetz DW. Evaluation and treatment of allergic fungal sinusitis. I. Demographics and diagnosis. J Allergy Clin Immunol 1998; 102:387–94.
- deShazo RD, Swain RE. Diagnostic criteria for allergic fungal sinusitis. J Allergy Clin Immunol 1995; 96:24–35.
- Cody DT II, Neel HB III, Ferreiro JA, Roberts GD. Allergic fungal sinusitis: the Mayo Clinic experience. Laryngoscope 1994; 104:1074–9.
- Kinsella JB, Bradfield JJ, Gourley WK, Calhoun KH, Rassekh CH. Allergic fungal sinusitis. Clin Otolaryngol 1996; 21:389–92.
- McCarthy DS, Pepys J. Allergic bronchopulmonary aspergillosis. clinical immunology: (1) Clinical features. Clin Allergy 1971; 1:261–86.
- Safirstein BH. Allergic bronchopulmonary aspergillosis with obstruction of the upper respiratory tract. Chest 1976; 70:788–90.
- Shah A, Pant CS, Bhagat R, Panchal N. CT in childhood allergic bronchopulmonary aspergillosis. Pediatr Radiol 1992; 22:227–8.
- Panchal N, Pant CS, Bhagat R, Shah A. Central bronchiectasis in allergic bronchopulmonary aspergillosis: comparative

- evaluation of computed tomography of the thorax with bronchography. *Eur Respir J* 1994; 7:1290–3.
- 20 Panchal N, Bhagat R, Pant C, Shah A. Allergic bronchopulmonary aspergillosis: the spectrum of computed tomography appearances. *Respir Med* 1997; 91:213–9.
- 21 Shah A, Panchal N, Agarwal AK. Allergic bronchopulmonary aspergillosis: the spectrum of roentgenologic appearances. *Indian J Radiol Imag* 1999; 9:107–12.
- 22 Mukherji SK, Figueroa RE, Ginsberg LE et al. Allergic fungal sinusitis: CT findings. *Radiology* 1998; 207:417–22.
- 23 Millar JW, Johnston A, Lamb D. Allergic aspergillosis of the maxillary sinuses [Abstract]. *Thorax* 1981; 36:710.
- 24 Katzenstein A-L A, Sale SR, Greenberger PA. Allergic *Aspergillus* sinusitis: a newly recognised form of sinusitis. *J Allergy Clin Immunol* 1983; 72:89–93.