Extensive Allergic Fungal Rhinosinusitis: Ophthalmic and Skull Base Complications

Ashish Vashishth

Received: 23 June 2014 / Accepted: 19 August 2014 / Published online: 26 August 2014
© Association of Otolaryngologists of India 2014

Abstract To review the clinical features, ophthalmic and skull base complications, radiologic correlates, surgical methods and outcomes in cases of extensive allergic fungal rhinosinusitis (AFRS). The retrospective review was carried out at a tertiary referral center and included 11 patients with extensive AFRS. Inclusion criteria were confirmed cases of AFRS with intracranial extension, gross erosion of the skull base or medial orbital wall and/or ophthalmic complications of AFRS, including visual loss. Acute bacterial or invasive fungal sinusitis and other non-AFRS sinus pathologies with orbital or skull base complications were excluded from the study. The mean age of patients was 22.7 years. Proptosis was the most common presenting feature followed by diplopia and visual loss. Four patients exhibited unilateral visual loss with one case of sudden acute onset. Intracranial extradural spread to the middle cranial fossa was observed in two cases with cavernous sinus involvement, destruction of the entire cranial base and extension to the petrous temporal bone. Ten patients exhibited co-existing orbital and skull base erosion whereas gross erosion of the lamina papyracea alone was seen in one patient. All patients underwent endoscopic sinus surgery with complete disease clearance. The minimum and maximum follow-up periods were 1 and 3 years, respectively with one documented recurrence 18 months after surgery. Visual recovery was complete after sudden vision loss whereas it was only partial or absent in patients with prolonged vision loss. Cases of extensive AFRS with ophthalmic and skull base complications pose diagnostic

and therapeutic challenges and merit early intervention with long-term follow-up.

Keywords Fungal · Sinusitis · Allergy · Skull base · Optic nerve · Complications · Vision loss

Introduction

The spectrum of fungal rhinosinusitis includes invasive and non-invasive forms with allergic fungal rhinosinusitis (AFRS) being the most common non-invasive variant. Traditionally a disease with slow and indolent clinical course, AFRS however, does cause expansion of bony walls with consequent thinning and eventual erosion, if unchecked. Skull base and orbital erosion have been described previously in the literature [1–4] with a much higher incidence in AFRS compared to non-AFRS inflammatory conditions of paranasal sinuses [5].

Aggressive bone erosion in AFRS can lead to a myriad of skull base and ophthalmic complications leading to significant morbidity and possibility of mortality [6–10].

Ophthalmic manifestations or complications of sinusitis range from orbital medial wall erosion seen on imaging to proptosis and visual loss in extreme cases. The proximity of critical neurovascular structures such as the internal carotid artery, cranial nerves, cavernous sinus, dura mater and cerebral lobes puts any or all of these at risk due to the disease process itself and in surgical management as well. Extensive AFRS cases with near-total destruction of the skull base and ophthalmic complications are still relatively rare phenomena with isolated presentations and reports [11, 12] and pose both a diagnostic and therapeutic challenge, often simulating malignancy or invasive fungal disease.

A. Vashishth (✉)
Department of ENT and Head and Neck Surgery, Vardhaman
Mahavir Medical College and Safdarjung Hospital, New Delhi,
India
e-mail: drashishvashishth@gmail.com

Though reports and descriptions of such cases are found in the literature [6, 7, 11, 12], an insight into surgical planning and intra-operative considerations is often lacking.

The objective of the present study was to review cases of extensive AFRS with orbital or/and skull base complications, including the presenting features, diagnostic features, pre-operative surgical planning, salient operative findings and post-operative outcomes.

Materials and Methods

A retrospective review was carried out to assess the clinical presentation, complications, surgical methods and post-treatment outcomes of cases with extensive AFRS presenting at a tertiary referral center between 2010 and 2013. Inclusion criteria were confirmed cases of AFRS with intracranial extension, gross erosion of the skull base or medial orbital wall and/or ophthalmic complications of AFRS. Acute bacterial or invasive fungal sinusitis and other non-AFRS sinus pathologies with orbital or skull base complications were excluded from the study. After scanning the clinical records, imaging records, operative notes and recordings and follow-up records, 11 cases were identified satisfying one or more criteria.

Note was made of the presenting complaints including duration of visual loss when present, CT and MRI features including sites of skull base and orbital erosion, status of major neurovascular structures at the cranial base, pre-operative planning, operative findings and post-operative/treatment outcomes. Operative variables recorded were approaches used in endoscopic sinus surgery, disease clearance and salient intra-operative landmarks in the presence of massive destructive disease, and the presence and management of operative complications, if any.

The follow-up period ranged from a minimum of 1 year to a maximum of 3 years. Any complications, disease recurrence or ostial stenosis occurring during the post-operative follow-up period were recorded.

Ophthalmic manifestations or complications were categorized using the grading system recently suggested by Al Anazy and Al Dousary [13] where grade I refers to anatomical disturbances, grade II refers to ophthalmic functional disturbances, grade III refers to orbital infections and grade IV refers to visual impairment.

All patients underwent computed tomography (CT) scans before surgical intervention. The sites of orbital and skull base erosion were noted. Radiologic scoring was performed as suggested by Wise and colleagues [14] to assess the correlation between radiologic and functional grading of bone erosion on CT scans. A score of 0 was given for no expansion or erosion whereas a score of 1 was

given for erosion of each of the walls of individual sinuses, 3 for each side of the frontal, ethmoid, maxillary and sphenoid sinuses with 1 for the intersinus septa of the sphenoid and frontal sinuses. This gives a maximum score of 24 for each patient [14]. Pre-operative surgical planning and assessment of the extent of radiological disease were carried out on the Osiri X MD (32 bit) platform on Mac computers and sections were analyzed in all three planes. MRI was done in cases with intracranial extension for assessment of extradural/intradural invasion, the cavernous sinus and the internal carotid artery.

IgE levels were measured in all patients pre-operatively. All patients were administered a 1 week course of oral steroids (prednisolone 1 mg/kg body weight) with antibiotics pre-operatively. Patients presenting with vision loss (sudden/progressive) were administered intravenous dexamethasone before definitive surgery. Steroids were continued in a tapering dose for 3 weeks following surgery. All patients administered steroids were prescribed calcium and vitamin D supplements. All patients with orbital or skull base erosion were administered oral antifungals (voriconazole) for 4 weeks following surgery. Topical steroids (fluticasone) were administered post-operatively beginning immediately following surgery along with aggressive saline nasal douching in the immediate post-operative period. In addition, short courses of oral steroids were administered in the late post-operative period on visualization of significant mucosal edema or polypoidosis.

All patients underwent endoscopic sinus surgery without any powered instrumentation. One patient required a Draf IIb procedure for clearance of disease from extensively pneumatized frontal sinuses with posterior table and roof erosion.

All patients underwent aggressive endoscopic evaluation and debridement in the post-operative period beginning on the 3rd post-operative day and subsequently on an alternate day basis till 2 weeks post-operatively. Endoscopic evaluation and debridement were continued on a monthly or quarterly basis depending upon the state of nasal mucosa and paranasal sinus cavities.

All patients were followed up post-operatively for disease recurrence, sinus patency and mucosal changes for a minimum of 1 year for some patients to a maximum of 3 years.

Results

The mean age of the 11 patients in the current study was 22.7 years with 6 males and 5 females. The mean age of patients in the visual loss group was 23.5 years with 3 females and a single male. Table 1 describes the ophthalmic complications or manifestations in the 11 patients

studied, along with their functional grading and radiological staging as described above.

Visual loss was left-sided in all four patients (grade IV) and of a progressive nature over a period of months (mean 4.6 months) in three patients, whereas it was sudden and acute in onset in one patient (negative perception of light). Two out of four patients (grade IV) had proptosis preceding visual loss for a mean duration of 3.5 months whereas two patients developed visual loss without any preceding proptosis. The improvement in vision was minimal in three patients who exhibited gradual, progressive and prolonged visual loss. The improvement in vision however, was complete in the patient presenting with sudden visual loss and occurred within 48 h of intravenous steroid administration, before definitive endoscopic sinus surgery. In all four cases, fundoscopy did not reveal any pathological finding.

Ten of the 11 patients exhibited co-existing orbital and skull base erosion whereas gross erosion of the lamina papyracea alone was seen in one patient. The mean radiologic score was 8.7 with a minimum score of 2 and a maximum of 20. The mean radiologic score however, in the four patients categorized as grade IV and exhibiting visual loss, was 12.3. Fig. 1 demonstrates CT scans showing erosion of the medial orbital wall and skull base.

All four cases with grade IV ophthalmic manifestations displayed complete occupancy of the sphenoid sinus with fungal debris and erosion of the sphenoid walls in multiple places. Table 2 summarizes the intracranial extension, cavernous sinus involvement and sphenoid involvement in grade IV cases. Though the cavernous sinus appeared involved or grossly compressed in two cases, no evidence of thrombosis was discovered on MR imaging. In the two patients with intracranial extension, the disease was extradural in both

cases, however, with a near-total destruction of the entire anterior, middle and posterior cranial base.

IgE levels were elevated in all four cases.

Operative Technique/Findings

Eight of the 10 patients with orbital and skull base erosion had completely distorted anatomy with total destruction of the middle turbinate as visualized intra-operatively. Initial debulking of polyps and fungal debris was followed by a large maxillary antrostomy in all cases, extending the antrostomy posteriorly as far as the posterior wall of the maxillary sinus. Maxillary sinus evacuation was followed by location of the medial orbital floor (MOF), which was used as a consistent landmark in all cases for location of the sphenoid ostium and skull base trajectory. The sphenoid ostium was always found to be located in the horizontal plane of the MOF. A sellar or presellar pneumatization of the sphenoid was observed in all cases with expansion consequent to localization of fungal debris inside the pterygoid recesses, the opticocarotid recesses and the posterosuperior and posteroinferior recesses. In addition to the 0° endoscope, we required angled endoscopes (30° and 70°) in 7 out of 10 cases for complete visualization and clearance of fungal debris from these recesses and in cases where complete encasement of the internal carotid artery was present. Frontal sinus clearance required a Draf IIb procedure in one case and a Draf IIa procedure in another for complete clearance of fungal debris. We found the use of angled endoscopes excellent for disease clearance from the sphenoid sinus, particularly in grade IV cases. No operative complication was encountered in any case. Fig. 2 demonstrates intra-operative images from the sphenoid sinus with a dehiscent carotid artery and optic nerve.

Table 1 Patient profiles

Patient	Age/Sex	Functional grading	Proptosis	Functional impairment	Visual loss	Duration of ophthalmological complaints	V/A	Radiologic score (max. 24)
1	20/M	IV	+	Epiphora	+	Proptosis—9 months, vision loss—5 months	6/24	20
2	22/F	IV	—	Diplopia	+	Vision loss and diplopia—6 months	6/24	15
3	30/F	I	+	—	—	Proptosis—12 months	—	2
4	24/M	II	+	Diplopia	—	Proptosis—12 months, Diplopia—1 month	—	2
5	18/M	I	+	—	—	Proptosis—3 months	—	8
6	22/M	IV	+	—	+	Proptosis—3 months, Vision loss—2 days	PL-ve	11
7	24/M	II	+	Diplopia	—	Proptosis—6 months	—	7
8	16/F	I	—	—	—	—	—	8
9	26/M	I	+	—	—	Proptosis—3 months	—	6
10	30/F	IV	—	—	+	Vision loss—5 months	PL-ve	3
11	18/F	II	+	Diplopia	—	Proptosis—8 months	—	14

V/A visual acuity, PL perception of light

Fig. 1 Computed tomographic images of patients with extensive AFRS demonstrating skull base and medial orbital erosion. **a** Axial scan demonstrating ethmoid expansion and erosion of the lateral and posterior walls of the sphenoid sinus with right-sided cavernous sinus. **b** Coronal scan demonstrating ethmoid expansion and erosion of right-sided lamina papyracea and roof of frontal sinus. **c** Coronal scan at the level of the sphenoid sinus with erosion of the lateral walls and clinoids. **d** Axial scan at the level of frontal sinuses exhibiting gross expansion and erosion of anterior and posterior tables with intracranial buckling. **e** Coronal scan demonstrating involvement and erosion of left-sided petrous temporal bone. **f** Coronal scan exhibiting left-sided clinoid and optic canal erosion

Post-operative follow-up revealed disease recurrence in a single case 18 months after primary surgery and treated with an uneventful revision endoscopic sinus surgery. No recurrence was observed in any other patient in the follow-up period though mild stenosis of the frontal neo-ostium was observed on one side in the patient in whom the Draf IIb procedure was used.

Discussion

Allergic fungal sinusitis is an entity seen in immunocompetent atopic individuals exhibiting hypersensitivity to fungal allergens. The allergic mucin and polyps are a hallmark of disease and may form a partially calcified mass obstructing sinus drainage and further propagating

Table 2 Skull base involvement in grade IV cases (vision loss)

Patient	Intracranial extension	Cavernous sinus involvement	Involvement of key areas of sphenoid
1	AE space with B/L frontal lobe compression. E space medial to B/L temporal lobes	Unilateral compression/ involvement	PS, DS, TS, CL, B/L OCR, right ICA compression (clinoidal)
2	E space medial to left temporal lobe, dural enhancement in B/L temporal regions	B/L compression/involvement	PS, DS, AC, PC, CL, left ICA encasement (clinoidal/paraclival)
3	–	–	OCR, lateral wall
4	–	–	OCR, DS, AC

B/L bilateral, *E* extradural, *AE* anterior extradural, *PS* planum sphenoidale, *DS* dorsum sellae, *TS* tuberculum sellae, *CL* clivus, *OCR* optico-carotid recess, *AC* anterior clinoid, *PC* posterior clinoid, *ICA* internal carotid artery

bacterial sinusitis. Growth of the mass causes expansion and remodeling of thin sinus walls leading to eventual erosion and possible extension to the orbit and intracranial cavity [1, 15].

Bone erosion in AFRS has been thought to be caused by persistent pressure, hyperemia and inflammation of surrounding mucosa, along with possible incipient infiltration by fungal elements and consequent granulomatous reaction [16].

Orbital and skull base erosion has been well documented in the literature with co-existence of both in a significant percentage of cases [4]. Ophthalmic manifestations range from proptosis most commonly [9, 13] to vision loss in extreme cases [7–10]. Vision loss is an extremely uncommon complication of AFRS with either a sudden acute [7, 10] or gradually progressive mode of presentation [10]. The mode of presentation and treatment outcomes differ in both forms of visual loss indicating a difference in respective pathologies. Common to most or all patients exhibiting visual loss is near-total erosion of the bony optic canal in the sphenoid sinus with direct neural exposure to the fungal debris and polypoidal or diseased mucosa [7, 10]. Proposed mechanisms of visual loss in sinonasal disease include optic neuritis due to an adjacent inflammatory process, central retinal artery occlusion or optic nerve venous congestion [17]. Optic neuritis due to the inflammatory process and critical retinal artery occlusion seem to be the underlying factors responsible for sudden vision loss in AFRS. This is supported by the fact that Thakar et al. [10] and Gupta and colleagues [7] reported good recovery of vision in cases of sudden or recent onset visual loss after surgical decompression and steroid use.

In the present series, one of four patients exhibiting visual loss was of sudden onset. Complete visual recovery (6/6) was observed even before surgical decompression due to intravenous steroid administration. This confirms the indication for urgent intravenous steroids even prior to surgical intervention to prevent adverse visual outcomes.

This is contrast to concerns expressed in previous studies [10] regarding the risk of fungal invasion from administering steroids prior to surgical debridement. Gradual and progressive visual loss, however, most commonly results from neural compression and a direct correlation seems to be present between the duration and prognosis of visual loss [8, 10]. This is in agreement with the findings in the present series where only partial recovery was observed in two of three cases of gradual visual loss with a direct correlation between degree of pre-operative visual loss and eventual recovery. The patient with no light perception for 6 months before presentation did not exhibit any significant improvement in visual acuity at the last recorded follow-up.

In the present series, two of the four patients with visual loss exhibited near-complete destruction of the lamina papyracea bilaterally along with destruction of the entire lateral, superior walls of the sphenoid sinus and clivus. Both cases exhibited intracranial extension into the middle cranial fossa with cavernous sinus involvement/compression and temporal lobe compression in the extradural compartment. Total erosion of the optic and carotid canal was noted in both cases with encasement of the paraclival and cavernous carotid and optic nerve by fungal debris. Both endoscopic and open approaches have been advocated in the past for extensive allergic fungal sinusitis cases with intracranial extension [7, 8, 10, 11]. We did not require an open approach for any case and endoscopic approaches were used in all cases with complete disease clearance intra-operatively. Detailed pre-operative surgical planning in three planes on the Osiri-X MD platform for Mac computers proved vital in evaluating anatomical orientation and assessment of skull base integrity in complicated cases. No powered instrumentation was used in any case. Though angled endoscopic control has been used in the past for frontal and maxillary sinus pathologies, in the present series, 30° and 70° angled endoscopic dissection was also used in the sphenoid sinus in cases with

Fig. 2 Intra-operative images of the sphenoid sinus. **a** 0° endoscopic image of the sphenoid sinus showing a dehiscent optic nerve and internal carotid artery with fungal debris superior and inferior to the optic nerve. **b** 30° endoscopic image showing removal of fungal debris from the opticocarotid recess with visibility of the middle fossa dura laterally. **c** Exposed optic chiasm in the sphenoid sinus after clearance of fungal debris

intracranial extension. Angled endoscopic dissection proved vital in ensuring total disease clearance in widely pneumatized and disease expanded sphenoid sinuses.

A Draf IIb procedure was required in one patient with excessively pneumatized frontal sinuses and posterior table erosion. Mild stenosis of the frontal ostium was observed after 6 months post-operatively which has stabilized since then. However, in retrospect, a larger and wider frontal cavity in the form of a Draf III procedure would have

enabled better post-operative control and long-term stabilization. Only a single patient in the current series presented with recurrence after 6 months, for which a revision endoscopic sinus surgery was performed. No iatrogenic complications were observed in the present series. In our series, the MOF proved to be the most consistent landmark for location of the skull base trajectory in the absence of other landmarks. Previous reports on extensive cases of allergic fungal sinusitis and vision loss do not elaborate on surgical details and methodology, which we feel is critical in avoiding morbidity and mortality in complicated cases.

The long-term follow-up of all the patients including serial and periodic endoscopic evaluation and debridement proved to be one of the most vital lessons in the above series. Regular follow-up provided critical windows of assessment of nasal mucosa for edema or polyposis and the paranasal sinuses for recurrent fungal debris collection. Endoscopic debridement and timely medical management in the form of short courses of oral steroids, lead to remission and disease control. Such mucosal changes, if unchecked, can lead to similar pre-operative circumstances requiring surgical intervention. Post-operative oral steroid therapy is well proven to improve symptoms and prevent early recurrences [18] and augments topical corticosteroids. The role of topical antifungals, however, needs to be evaluated to prevent recurrences. Lack of availability of topical azoles in intranasal formulations and the cost of amphotericin B for nasal irrigation precluded their use in the current cohort of patients.

Radiologic scoring was performed as suggested by Wise and colleagues [14] and functional grading as proposed recently by Al Anazy and Al Dousary [13]. We could not find an absolute correlation between functional grading and radiologic scoring, though the patients with intracranial extension demonstrated the highest radiologic scores. Though functional grading seems appropriate in grading patients with ophthalmic complications, radiologic scoring cannot always be correlated with severe symptomatology. Radiologic scoring does not account for bone erosion at critical cranial base locations and neurovascular structures such as the internal carotid artery, cavernous sinus and optic nerve.

Limitations and Recommendations

Although a prospective study with predesigned protocols and comparisons would be ideal, this seems extremely difficult in the present scenario because of the uncommon nature of cases with extensive disease and with the urgency required in management. A longer follow-up period opens up the prospect of evaluating eventual ophthalmological recovery and disease recurrence. A lifelong follow-up is recommended for all patients with extensive allergic fungal

sinusitis causing ophthalmic and skull base complications and erosion to prevent future complications or recurrence in an already compromised paranasal anatomy.

Conclusions

Bone expansion and erosion associated with AFRS causing orbital and cranial base erosion can lead to significant morbidity in terms of ocular symptoms and vision loss with the possibility of mortality because of the proximity and possible involvement of critical neurovascular structures such as the cavernous sinus, internal carotid artery and brain parenchyma. Despite severe extension, disease remains in the extradural compartment in most cases, enabling complete removal by endoscopic endonasal approaches. Medical therapy in the form of intravenous steroids is critical in the management of sudden visual loss, optimization of the surgical field and outcomes and prevention of recurrences. Careful pre-operative surgical planning on dedicated imaging platforms and early identification of the MOF and skull base intra-operatively lead to better surgical outcomes.

Conflict of Interest The authors declare that they have no conflict of interest.

References

1. Michaels L, Lloyd D, Phelps P (2000) Origin and spread of allergic fungal disease of the nose and paranasal sinuses. *Clin Otolaryngol* 25:518–525
2. Kinsella JB, Rassekh CH, Bradfield JL, Chaljub G, McNee SW, Gourley WK et al (1996) Allergic fungal sinusitis with cranial base erosion. *Head Neck* 18:211–217
3. Liu JK, Schaefer SD, Muscatello AL, Couldwell WT (2004) Neurosurgical implications of allergic fungal sinusitis. *J Neurosurg* 100:883–890
4. Marfani MS, Jawaid MA, Shaikh SM, Thaheem K (2010) Allergic fungal rhinosinusitis with skull base and orbital erosion. *J Laryngol Otol* 124:161–165
5. Ghegan MD, Lee FS, Schlosser RG (2006) Incidence of orbital and skull base erosion in allergic fungal rhinosinusitis (AFRS) and non-AFRS. *Otolaryngol Head Neck Surg* 134:592–595
6. Bozeman S, deShazo R, Stringer S, Wright L (2011) Complications of allergic fungal sinusitis. *Am J Med* 124:359–368
7. Gupta AK, Bansal S, Gupta A, Mathur N (2007) Visual loss in the setting of allergic fungal sinusitis: pathophysiology and outcomes. *J Laryngol Otol* 121:1055–1059
8. Marple BF, Gibbs SR, Newcomer MT, Mabry RL (1999) Allergic fungal sinusitis-induced visual loss. *Am J Rhinol* 13:191–195
9. Karter KD, Graham SM, Carpenter KM (1999) Ophthalmic manifestations of allergic fungal sinusitis. *Am J Ophthalmol* 127:189–195
10. Thakar A, Lal P, Dhiwakar M, Bahadur S (2011) Optic nerve compression in allergic fungal sinusitis. *J Laryngol Otol* 125:381–385
11. Meccariello G, Deganello A, Mannelli G, Bianco G, Ammannati F, Georgolas C et al (2013) Allergic fungal rhinosinusitis infiltrating anterior skull base and clivus. *Auris Nasus Larynx* 40:405–408
12. Reitzen SD, Lebowitz RA, Jacobs JB (2009) Allergic fungal sinusitis with extensive bone erosion of the clivus presenting with diplopia. *J Laryngol Otol* 123:817–819
13. Al Anazy FH, Al Dousary SH (2012) Ophthalmic manifestations of paranasal disease: a clinical grading system. *Int Forum Allergy Rhinol* 2:331–335
14. Wise SK, Rogers GA, Ghegan MD, Harvey RJ, Delgaudio JM, Schlosser RJ (2009) Radiologic staging system for allergic fungal rhinosinusitis (AFRS). *Otolaryngol Head Neck Surg* 140:735–740
15. deShazo RD, Chapin K, Swain RE (1997) Fungal sinusitis. *N Engl J Med* 337:254–259
16. Thakar A, Dhiwakar M, Sarkar C, Bahadur S, Dahiya S (2004) Allergic fungal sinusitis: expanding the clinic-pathological spectrum. *Otolaryngol Head Neck Surg* 130:209–216
17. Patt BS, Manning SC (1991) Blindness resulting from orbital complications of sinusitis. *Otolaryngol Head Neck Surg* 104:789–795
18. Rupa V, Jacob M, Mathews MS, Sheshadri MS (2010) A prospective, randomized, placebo-controlled trial of oral postoperative steroids in allergic fungal sinusitis. *Eur Arch Otorhinolaryngol* 267:233–238