Identification of Allergic Fungal Sinusitis (AFs) by MDCT and MR Imaging

Nadia Abd El Sater Metwally[1]; Hoda Mohammed Abd El Wahab[1]; Bothina Ahmed Mohammed[2]

[1]Radiodiagnosis Department, Faculty of Medicine for Girls – Al Azhar University Cairo, Egypt
[2]ENT Department, Faculty of Medicine for Girls – Al Azhar University Cairo, Egypt
Dr. Hani.hammam@gmail.com

Abstract: Objective: Fungal related disease of the paranasal sinuses encompasses a broad spectrum of clinical entities, ranging from mildly symptomatic to rapidly fatal. Allergic funal sinusitis (AFs) is differe from other forms of fungal sinusitis and often misdiagnosed, therefore its recognition will lead to multimodality treatment which heavily relies on surgery and corticosteroids. **Aim of the Work:** To determine CT and MR diagnostic findings in patients with allergic fungal sinusitis. **Subjects and Methods:** (16) patients with an age ranged from (11-56 years) with clinical symptoms of chronic sinusitis and suspected to have allergic fungal sinusitis (AFs) were conducted in this prospective study. All patients underwent MDCT imaging and eight of them had MR examination of the Paranasal sinuses. All CT and available MR images were reviewed with respect to the clinical symptoms, laboratory findings and were confirmed by histopathological results in patients who underwent surgery. **Results:** Adult males were commonly affected in 10(62.5%) with M:F ratio (1.6:1) patients the mean age (35.2years). Non contract in enhanced CT showed central areas of hyperdensity within the involved opacified sinuses. T1 and T2 weighted MR images revealed hypointense or signal void with or without peripheral enhancement. A symmetrical bilateral pansinusitis diagnosed in 12(75%) patients, unilateral in 3(18.7%) and isolated sphenoid sinus involvement in 1(6.2%). Sinus expansion seen in 15(93.7%), polyposis seen in 12(75%) amd localized bone erosion in 8(50%) patients with extra-sinus extension. The main bulk of the disease being intrasinus rather than extrasinus, were another diagnostic imaging feature of allergic fungal sinusitis. **Conclusion:** Allergic fungal sinusitis is a distinct clinical entity with non specific symptoms. While CT may suggest its initial diagnostic features, MR gives accurate assessment of the extrasinus extension. These radiological findings should alert the clinician to use appropriate diagnostic techniques for confirmation and for therapy planning.

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1. Introduction

Chronic sinusitis affect (14%-16%) of adult population. Fungal sinusitis was considered a rare disorder, but now it has been reported with increasing frequency. On the basis of international society of human and mycology (2008), fungal sinusistis distinguished into invasive and non invasive forms. Invasive type divided into (acute – chronic and granulomatous), while non invasive divided into (fungal ball "mycetoma" – allergic). It is a challenging form of sinus pathology, especially the invasive forms which have high mortality rate.(1)

Allergic fungal sinusitis (AFs) has been labeled as an equivalent to the bronchopulmonary aspergillosis. It is reported to have incidence of (6%-8%) of all chronic sinusitis treated surgically and (75%) associated with polyposis.(2)

Patients are often a topic with chronic inflammatory disorder of paranasal sinuses and have eosinophilia with elevated fungal specific immunoglobulin (IgE). Higher incidence has been reported in African American patient suggested a genetic susceptibility. In contrast to race, there was no sex predilection for associated bone erosion. Although is non invasive, if untreated sinus expansion and bone erosion can lead to intraorbital or intracranial extension with dramatic clinical presentation.(3)

Functional endospic sinus surgery (FESS) has revolutionized the treatment of sinusitis, CT and MR imaging has also progressed and demonstrated normal sinus anatomy, normal bone variations and pattern of sinusitis requested before surgery. Radiological features with clinical presentation are critical for early diagnosis, treatment and prognosis of AFs, which is different from other forms of fungal sinusitis. Non contrast enhanced CT findings heterogeneous opacity with central hyperattenuation and MR T2 weighted hypointensity or signal void are the characteristic diagnostic features.

2. Patients and Methods

This prospective study included (16) patients, with an age ranged from (11-56 years) (10) were males and (6) were females with M:F ratio (1.6:1). They referred for paranasal sinus examination from the ENT Department to the Radiology Department in

Al Zahraa University Hospital between the year of (2014-2016).

They were assessed for their (clinical symptoms, onset, duration, time interval of recurrence, previous surgical intervention and therapy intake) as well as laboratory and histopatholgocial investigations.

Table (1): Depending on their clinical presentations and nasal endoscopy, they were classified as follows.

Clinical Symptoms		**Patients (No=16)**
1- Chronic sinusaitis	*Chronic headache - nasal polyposis one of them had (uncontrolled asthma and bronchiectasis) on previous CT chest.*	6(37.5%)
2- Nasal obstruction	*With offensive discharge.*	2(12.5%)
3- Proptosis	*(Two) were post operative and (one) had Epistaxis.*	3(18.7%)
4- Unilateral facial (maximally swelling)	_____	1(6.2%)
5- Previous surgery	*With 3-5 years interval time from recurrent symptoms or complications (proptosis, nasal obstruction, sleep apnia and one had C.S.F rhinorrhea).*	4(25%)

All patients had easinophillia and were immunocomptent and those underwent surgery had positive allergic mucin stain and scanty hyphae in culture.

Radiological evaluation was made for all (16) patients by **(MDCT Toshiba Aquillion Prime-160 Slice-Japan)**. Routine non contract axial and coronal scan at (3-5 mm) contiguous sections in both bone and saft tissue windows, with 3D reconstruction on a separate vitrea workstation.

MR examination was performed only in (8) patients by **(1.5 Tesla)** in a private radiology center. All images obtained in pre and post contrast T1W and T2W sequences.

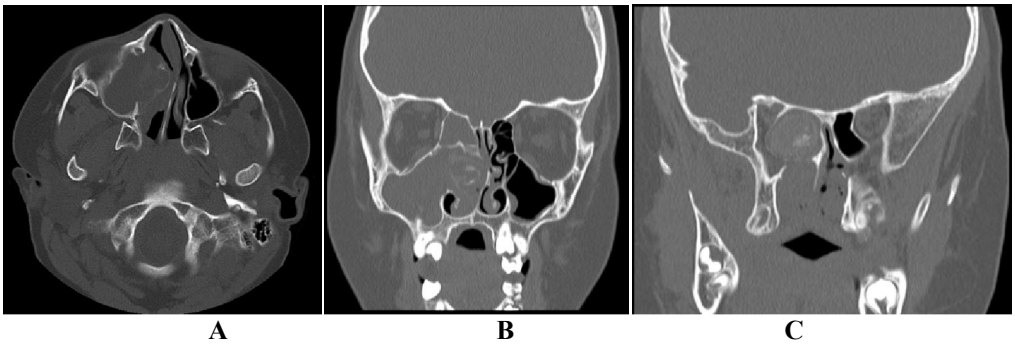
Both CT and MR images were reviewed with respect to the clinical presentation, for the (site and number of involved sinus, polypoid mucosal changes, echogencity of pathological tissue relative to the ocular muscle on CT, signal intensity relative to the brain on MR, associated sinus expansion, bone erosion, remodeling and extrasinus extension). Combination of these imaging features considered a radiological characteristic findings for allergic fungal sinusitis (AFs).

3. Results

As show on CT images, all 16(100%) patients showed heterogeneous sinus opacity with central focal areas of hyperdensity one of them showed scattered foci of calcification.

Out of total (16) examined patients, 12(75%) showed pansinusitis, 3(18.7%) had hemi-pansinusitis and 1(6.2%) had isolated sphenoid sinus involvement**.** Both ethmoid and maxillary sinuses had a predominance affection, each diagnosed in 15(93.7%), followed by sphenoid 14(87.5%) and frontal in 13(81.5%) patients. Sinus expansion diagnosed in 15(93.7%) patients, remodeling and bone thinning in 14(87.5%) bone erosion in 14(87.5%) and bone sclerosis in 1(6.2%) patient.

Polypoid changes with nasal involvement seen in 12(75%) patient and (1) of them had extension to the nasopharynx. Air bubble / air – fluid level (denoting acute on top of chronic) seen in 3(18.7%) patients.



A **B** **C**

Fig. (1): (A) Axial, **(B, C)** Coronal CT scan: Sinonasal opacity with bone remodeling, rarefaction of medial maxillary wall and ethmodial septation, Lt. sided deviated nasal septum. Double density with central density is noted at Rt. expended sphenoid sinus.

Extension of the pathological tissue beyond the involved sinuses, diagnosed as intraorbital /extraconal involvement in 5(31.5%) patients, (4) from ethmoids and (1) from frontal sinuses and (2) of them were

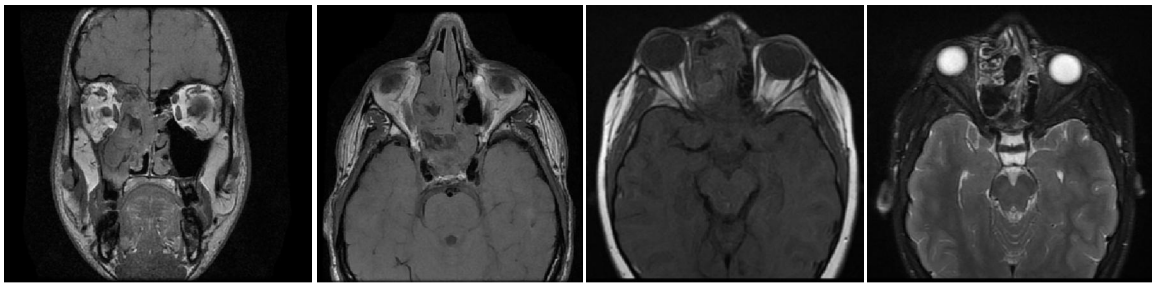
postoperative. Radiological features referring to such extension included (defect in lmina papyracea, obliteration of peri-orbital fat, abutting uvelosclera with ill- definition of lacrimal gland, displacement of the medial rectus muscle (causing proptosis) and encroachment upon the optic nerve canal) **Fig. (1).**

Intracranial extension diagnosed in 3(18.7%) patients, it occurred via a localized bone erosion at the sites of (cribriform plate of ethmoid and planum sphenoidale), resulting in encroachment upon the (intra- cavernous portion of ICA and foramen rotundum). All diagnosed intracranial extension was confined to the extradural space without invasion for the brain parenchyma or intracranial vessels**.**

Post contrast T1W MR images showed linear C.S.F intensity along the lateral nasal wall correlated the site of bone defect, made confirm the diagnosis for a case presented with C.S.F rhinorrhea.

Table (2): Available MR images of (no. 8) patients showed variable signal intensity **Fig. (2)**.

Patient (No= 8)	**MR findings**
3 patients	***T1 W and T2 W signal void with peripheral enhancement***
2 patients	***T1 W isontense, T2 W hypointense without enhancement***
3 patients	***T1 W hypointense, T2 W hyperintense with heterogeneous enhancement***



A **B** **C** **D**

Fig. (2): (A, B, C) Coronal and axial T1W imaged: Rt. Sinonasal of isointensity with areas of signal void, displaced proptotic orbit with encroachment upon the Rt. optic nerve canal. **(D)** Axial T2W image revealed the characteristic heterogonous signal intensity soft tissue mass within the expended Rt. sinonasal structure. MR findings consistent with (AFs).

4. Discussion

Fungal allergy is clearly linked to a subset of chronic rhinosinusitis known as allergic fungal sinusitis. It represents intense allergic response against colonizing fungi, given rise to the formation of the allergic easinophillic mucin, mucostasis and sinus opacification.[4]

While***, Robson et al.***[5] who introduced the term of allergic fungal sinusitis (AFs), it was ***Cody et al.***[6] who reported that aspergillus species responsible for (15%) of (AFs).

Allergic fungal sinusitis occurs in younger, immunocomptent adults compared with other forms of fungal sinusitis, they usually endure years of nasal congestion and chronic headache (features of chronic sinusitis).[7] A male predominance in our study was M:F ratio (1.6:1) which also has been documented as (1.4:1) by ***Lu-Myers et al.***[8]**.**

Because the diagnosis is often delayed and many patients presented with complications, diagnostic imaging is an important tool of early detection and management. MDCT proved to give the overall anatomic details for the P.N.S. and the osteometal complex. Evaluation for sinus echogencity revealed heterogeneous apacity with central focal or diffused areas of hyperdensity in all examined 16(100%) patients. Similar results reported by ***Dillon et al.***[9] in his (23 studies).

Central areas of hyperdensity explained by ***Sato-Aguilor et al.***[10]**,** who state that fungi have C.T. attenuation value of (1070-3070 Hu.), average (2068 Hu). ***Aribandi and Bazan***[11] explained this hyperdensity as result of combined inspissated sinus secretion and deposition of intrafungal of heavy metals (Calcium, iron, manganese). Although this feature is highly suggestive of (AFs), it is not pathognemonic since, it can be seen in (retained secretion of chronic nonfugal sinusitis, mucocele and chondrogenic osseous tumor).

Additional imaging characteristics are asymmetrical sinus multiplicity. Which diagnosed in 12(75%) patients, while 3(18.7%) showed unilateral affection and only 1(6%) has isolated sphenoid sinus involvement**.** Prevalence of involved sinuses diagnosed with equal rate for both ethmoid and maxillary sinuses, each had 15(93.7%), followed by sphenoid 14(87.5%) and frontal in 13(81.5%) patients.

Our result consistent with ***Som and Curtin***[12] who stressed that ethmoid was the most common primary site of fungal of infection, however ***Corey et al.***[13], reported that ethmoid predominance is documented in both (AFs) and chronic non fungal sinusitis without definite explanation. Ethmoid sinuses were virtually ignored in sinusitis and could not accurately evaluated by conventional X-ray, however advent of CT and MR imaging shifted the emphasis of ethmoid sinus. It is now accepted the common site of low grade infection with localized symptoms which can predispose to recurrent spread of infection into maxillary and frontal sinuses.

Gorovoy et al.[2], reported that bony sclerosis and thinning are common findings in (AFs) and often associated with sinus expansion. In our study bone sclerosis diagnosed only in 1(6.2%) patient, while sinus expansion showed in 15(93.7%) and remodeling in 14(87.5%), finding similarly reported by ***Schubert***[14] as (93%-98%) in their studies.

Concerning CT feature of bone erosion, we detected it in 8(50%) patients, finding supported by ***White et al.***[3] was (53%). ***Marple et al.***[15] explained that erosion a result of bone necrosis or the effect of inflammatory mediator rather than true bone invasion. Associated polyphoid changes diagnosed in 12 (75%) patients, findings consistent with.[16]

Although progression of (AFs) into invasive form is rare, its occurrence facilitated by the spread through the bony defects seen at the time of diagnosis if the sinus mucosa is violated. Out of the total (16) examined patients 8 (50%) patients had bone erosions. Intraorbital extension diagnosed in 5 (31.5%) patients, in agreement with ***Bozeman et al.*** [17]. who reviewed orbital involvement in (38%) as the most common complication of (AFs) associated with a rate of bone erosion range from (20%-90%).

We agree with ***Patel et al.***[18], who reported that obliteration of peri-obrital fat is the subtle sign of intraorbital extension from ethmoid which may be misdiagnosed as orbital inflammatory pseudotumor. Out of previously diagnosed (5) patients, (4) were involved from ethmoid sinus affection and (1) from frontal sinus, (2) patient were post operative with recurrent proptosis. In all patients extension was intraorbital/extraconal.

Intracranial extension was noted in 3 (18.7%) patients, MDCT showed bone erosion in (the planum sphenoidale and cirbiform plate of ethmoid). Despite of the encroachment upon (the cavernous portion of I.C.A., optic nerve canal and foramen rotendum), Infection was confined to the extradulral space without brain parenchyma or neurovascular invasion. One patient had postoperative recurrent presentation and the other had C.S.F rhinorrhea a result of extension via the bone erosion in the cribriform plate of ethmoid.

Fungal brain abscess was considered another complication of (AFs) it was not seen in our study, however it was reported by ***Tsimikas et al.***[19] who suggested that surgical penetration of nucosa and dura were the possible mechanism of involvement. However, ***Holbrook et al.***[7] explained another mechanism by direct spread via the foramen oval and Meckel's cave.

Another rare association reported by ***Chen and Chiang***[20], who described the first case of allergic fungal otomastoditis follow by ***Kumar et al.***[21], who reported allergic mucin and polyps within the middle ear in patients with (AFs) without history of middle ear disease.

MR images obtained from the examination performed for (8) patient, (4) of them presented with postoperative recurrent symptoms or having a newly developed complications. Evaluation for MR signal intensities showed (5) patients had T1 and T2W (hypointensity or signal void) with or without peripheral enhancement another (3) patient had T1W hypointensity and T2W hyperintensity with heterogeneous enhancement.

Zinreich et al.[22] explained that signal loss on T1 and T2w in (AFs), depending on the sinus secretion viscosity and protein contents, spectrum of MR signal is produced. As the protein content (less or equal to 5%), there was T1 hyperintensity and T2 hyperintensity as the protein increase (5%-25%) T1 increases gradually, and T2 remains high. Finally as the protein increase (25%-40%) there is hypointensity or signal void in both T1 and T2 w-images. In addition, ***Manning et al.***[23] explained MR hypotintensity or signal void in (AFs) because of the paramagnetic effect of heavy metal (iron, calcium, manganese) within the fungi.

In conclusion allergic fungal sinusitis is a chronic disease, that may recur even after intense surgical and medical management, stressing the need for continued follow up to promote best patient outcomes. Radiologist should be ware about imaging features and classification of fungal sinusitis. MDCT is crucial for early diagnosis and worns the clinician about the exiting or impending complication, it allows image reconstruction from single image data with low radiation dose. Coronal reconstruction provides views similar to those seen by endoscope, while axial and sagittal are useful in delinating anatomic abnormalities, findings important prior to sinus surgery. MDCT also exclude presence of aggressive infection. Extra-sinus extension beyond the involved sinuses requires MR examination, to evaluate skull base erosion, intracranial invasion and its relation to the vital neurovascular structures. Early therapy aimed

to eradicate fungi completely and allow natural drainage pathway. Surgical therapy remaining the cornerstone for his recidivistic disease. Postoperative access should be kept in mind to diagnosis recurrence.

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