

Fungal Sinusitis: Radiological Aspects

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Abstract

Introduction: Fungal sinusitis is a well-known entity. They are grouped into invasive forms and non-invasive forms. The diagnosis is often late and difficult given the varied and non-specific nature of the clinical signs. Invasive forms, which cause serious complications that are life-threatening, require rapid diagnosis. The objective was to illustrate the different radiological aspects of fungal sinusitis by specifying for each group its clinical and anatomo-mycological particularities.

Methods: This was a retrospective study of 30 cases of fungal sinusitis collected in service over a 20-year period (1998-2017). All patients had an imaging.

Results: Our series included 30 cases divided into 16 cases of fungal ball, 5 cases of allergic form, 5 cases of chronic invasive fungal sinusitis and 4 cases of mucormycosis. A female predominance was noted with a sex ratio of 0.3. The clinical picture was nonspecific. The functional signs were dominated by rhinorrhea, nasal obstruction and facial pain. Imaging, based on CT (Computed tomography) and/or MRI, was performed in all patients. The radiological signs varied according to the type of fungal attack. All patients were operated on. The diagnosis was mycological and/or pathological.

Conclusion: The clinical picture of fungal sinusitis is nonspecific. However, one must know how to think of the invasive forms before any trailing sinusitis on a field of immunodepression. Imaging is of great value in the diagnostic and therapeutic approach.

Keywords: Sinus of the face; Aspergillosis; Mucormycosis; Imaging

Introduction

Fungal sinusitis is a well-known entity. Several fungi have been implicated to cause sinus infection. Aspergillus is the most commonly implicated organism causing fungal sinusitis. To date, the most widely adopted classification through several publications distinguishes two groups; invasive forms and non-invasive forms based on the presence or absence of tissue invasion by the fungal agent on histological examination [1-3]. Invasive fungal sinusitis is subdivided into acute invasive fungal sinusitis, chronic invasive fungal sinusitis, and chronic granulomatous invasive fungal sinusitis. Non-invasive fungal manifestations are allergic fungal sinusitis and fungus ball (fungal mycetoma). The diagnosis is often late and difficult given the varied and non-specific nature of clinical signs. Invasive forms, which cause serious and life-threatening complications, require a rapid diagnosis. Our series included 30 cases of fungal sinusitis collected over 20 years from January 1998 to December 2017.

The objective was to illustrate the different radiologic features of fungal sinusitis by specifying for each group its clinical and mycological particularities.

Materials and Methods

We conducted a retrospective study of 30 patients with fungal sinusitis treated over 20 years (January 1998-December 2017). We included in this study all patients operated on and followed for fungal sinusitis in the Department of Otorhinolaryngology, Rabta Hospital, Tunisia. The diagnosis was made on the pathological and/or mycological examination. Patients with no imaging were excluded (CT and/or MRI). Facial CT scan (Computed tomography) in axial and coronal sections was performed preoperatively in all patients. Magnetic resonance imaging (MRI) has been requested in addition to the scanner. This

examination included T1 and T2 weighted sequences and a T1 sequence after gadolinium injection. We evaluated the images for characteristics of opacity produced by the diseased tissue, sinuses involved, expansion of sinuses, areas of bone erosion and extra-sinus extension. The Rabta Hospital's ethical committee board approved the study.

Results

We collected 21 cases of non-invasive forms (16 cases of the fungal ball and 5 cases of allergic fungal sinusitis) and 9 cases of invasive forms (5 cases of invasive pseudotumoral form and 4 cases of mucormycosis). The average age of our patients was 45.5 years with extremes ranging from 17 to 75 years old. We noted a clear predominance of women (7 men/23 women) with a sex ratio of 0.3. Seventeen patients had dental pathology. Six patients had a history of type II diabetes. They had the local non-invasive form and acute fulminant form. Immunosuppressive treatment was found in 2 patients with the local non-invasive form and one patient with mucormycosis: this was a patient under imurel for ulcerative colitis for 1 year, a patient on long-term corticosteroid therapy for rheumatoid arthritis and a patient followed for hematological malignancy. Five patients had a history of nasosinus polyposis resistant to medical treatment associated with asthma in one case. Allergic rhinitis has been

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reported in 6 cases. A history of treatment-resistant chronic sinusitis has been reported in 4 cases.

All patients with chronic invasive form were immunocompetent. The average consultation time was 2.5 years in fungal balls (range 5 months to 10 years), 1.8 years in allergic forms (range 1 to 4 years), 1 year in chronic invasive form (extremes of 9 months to 1.5 years) and 13 days (6 days to a month extreme) for fulminant forms. Functional signs were dominated by rhinological signs such as rhinorrhea (26 cases) and nasal obstruction (24 cases). Odor disorders were reported by 7 patients, 5 of whom presented with the allergic form. Hot, painful swelling of the hemisphere rapidly increasing volume associated with hemiface pain was noted in cases of mucormycosis. Ophthalmologic signs were noted in 3 patients presenting the invasive chronic form (unilateral exophthalmia in 2 cases and bilateral in 1 case, periorbital edema in 2 cases, visual blur in 1 case) and in 2 patients with fulminant form (one exophthalmos and decreased visual acuity). Anterior rhinoscopy coupled with nasal endoscopy, performed in all patients, revealed a polyp of inflammatory appearance in 6 cases and translucent polyps filling the nasal fossae related to nasosinus polyposis in 5 cases.

Examination of the oral cavity revealed multiple dental caries in 6 cases, scars of old extractions of sinus teeth in 8 cases, an antro-buccal fistula in one case and hard necrosis of the palate in the 3 patients with mucormycosis. Examination of the face revealed swelling of the hemiface, painful and poorly limited in all cases of mucormycosis. One patient presented a necrotic cupboard of the hemiface after 48 hours of hospitalization. A specialized ophthalmic examination was performed in the five patients with exophthalmos. It had objectified painless reducible exophthalmos in non-fulminant cases and painful in fulminant forms. A decrease in visual acuity with ophthalmoplegia was noted in two of these cases.

All our patients had a CT scan which made it possible to specify the seat, the aspect and the balance of extension to the adjacent organs. The attack was unilateral in all cases of fungal balls and interested the maxillary sinus in 13 cases. Isolated involvement of the sphenoid was noted in 2 cases (Table 1).

For the 16 cases of fungal balls (Table 2), CT showed typical aspects in 14 cases. It was a high density area (Figure 1) or microcalcifications within a total or partial filling of a sinus (Figures 2 and 3). In the other two cases, the CT scan showed partial filling of the maxillary sinus in one case, and heterogeneous ethmoido-maxillary filling associated with bone lysis in the other case (Figure 4). Signs related to the chronicity of sinusitis were reported as lysis of the medial wall of the maxillary

Form	Affected sinus	N
Fungus ball	Maxillary sinus	13
	Maxillary sinus and ethmoid sinus	1
	Sphenoid sinus	2
	Ethmoid sinus and maxillary sinus	1
	Frontal sinus, ethmoid sinus and maxillary sinus	1
Chronic invasive form	Pansinusitis	3(bilateral: 1 case)
Allergic fungal sinusitis	Pansinusitis	bilateral : 4 cases
		unilateral : 1 case
Acute invasive fungal sinusitis	Ethmoid sinus and maxillary sinus	2 cases
	Unilateral pansinusitis	2 cases

Table 1: Paranasal sinus localizations.

CT features	Fungus ball (n=16)	Chronic invasive form (n=5)	Allergic form (n=5)	Acute invasive form
High density area	7	-	-	-
Microcalcifications	7	1	1	-
Total or partial opacification without microcalcifications or High density area	2	-	-	4
Hyperattenuating filling	-	2	2	-
Pseudotumoral features	-	2	-	-
Extension to nasal cavity	2	5	5	4
Bone lysis	2	5	2	4
Intracranial extension	-	3	-	1
Orbital involvement	-	3	-	4

Table 2: CT findings.

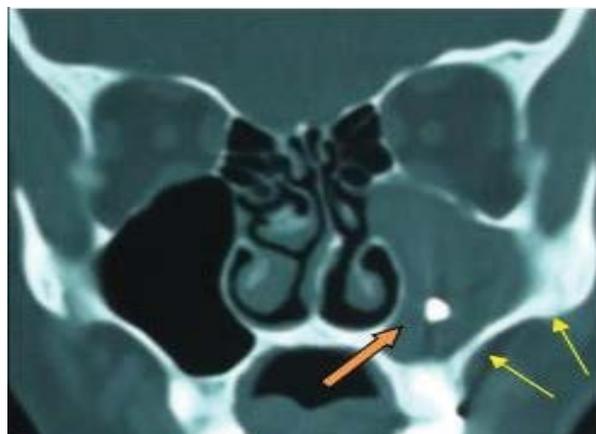


Figure 1: CT scan imaging coronal section, bone window: Left intra-maxillary foreign body with filling and thickening of the sinus walls.



Figures 2: CT scan imaging, coronal section, bone window Total filling of the left maxillary sinus extended to the middle meatus and seat of multiple calcifications.

sinus in 2 cases and the floor of the sphenoid in 1 case (Figure 5) and an aspect of osteosclerosis that interested the sinus walls maxillary in 8 cases (Figure 1), and sphenoid in 1 case (Figure 6).



Figure 3: CT imaging, sagittal section, parenchymal window: Filling of the sphenoidal sinus containing scattered calcifications.

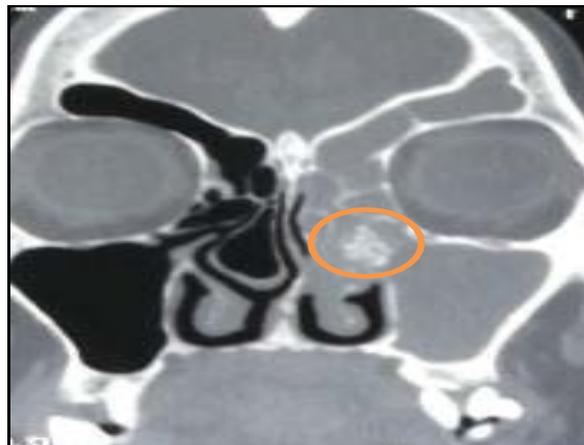


Figure 6: CT imaging, coronal section, bone window: amorphous and irregular calcifications.



Figure 4: CT imaging, coronal section, bone window: Right ethmoido-maxillary filling with lysis of the inter-sinus nasal septum, extension to the nasal fossa and septum discharge.

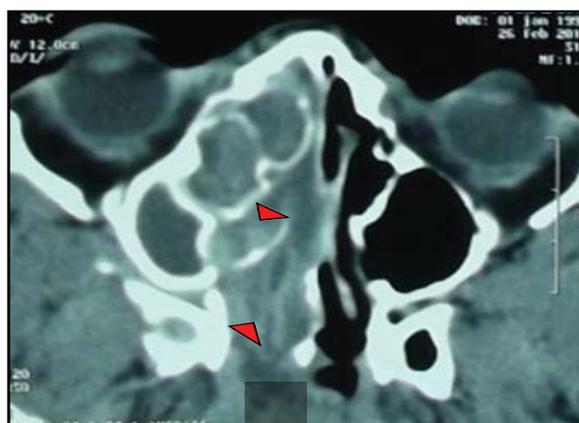


Figure 7: CT imaging, axial sections, parenchymal window: Total filling of the right maxillary sinus and ethmoid cells, spontaneously hyperdense in places, blowing the cortex and pushing back the septum in the form of allergic fungal sinusitis.

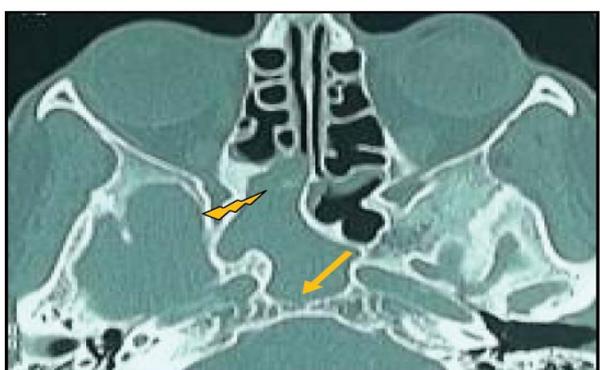


Figure 5: CT imaging, axial section, bone window: Filling of the right sphenoid seat of a microcalcification with localized osteolysis of its posterior wall.



Figure 8: CT imaging, coronal section, bone window: Total filling of the right maxillary sinus and ethmoid cells, spontaneously hyperdense in places, blowing the cortex and pushing back the septum in the form of allergic fungal sinusitis.

In allergic fungal sinusitis, disease tends to be bilateral with involvement of multiples sinuses. Complete opacification and expansion of the involved sinus are noted in all cases. Noncontrast CT demonstrates hyperattenuating allergic mucin within the lumen of the paranasal sinus in two cases (Figure 7 and 8).

In cases of chronic invasive sinusitis, CT showed pansinusial filling with calcium-rich hyperdense plaques in 2 cases strongly suggestive of fungal origin (Figures 9-11), an expansive, heterogeneous tissue process, taking the product contrast in 2 cases (Figure 12) and homogeneous filling in one case. It allowed to establish the assessment of extension to the adjacent organs by showing a lysis bone interesting ethmoidal partitions, the papery leaf (3 cases), the nasal septum and the intersinusial partition (1 case), the floor of the frontal sinus (1 case), the lateral wall of the sphenoid (1 case) (Figure 10). Intracranial and orbital extension were noted in 3 cases (Figures 9,11,13) and cavernous sinus invasion in 1 case (Table 2).

For the cases of mucormycosis, all the patients had a CT of the facial solid mass in urgency. She had shown homogeneous ethmoido-maxillary filling in 2 cases (Figures 14 and 15) and pansinusial in 2 cases (Figure 16). Cellulitis of the orbitofacial region was noted in all cases as well as an extension to the deep spaces of the face and multiple bone lysis. Thrombosis of the right cavernous sinus and right internal carotid artery was noted in one case. Complement with craniofacial MRI was requested in 5 cases, in 3 cases of chronic invasive form, in 1 case of the fungal ball and 1 case of mucormycosis.



Figure 9: CT imaging, axial sections, parenchymatous window: Filling heterogeneous pansinusien spontaneously hyperdense containing right of microcalcifications with orbital and intracranial extension in chronic invasive form.



Figure 11: CT imaging, sagittal, parenchymal window: Spontaneously hyperdense filling of cavities with lysis of the lateral wall of the sphenoid and endocranial extension in the chronic invasive form.



Figure 12: CT imaging, axial section, parenchymatous window: Filling of ethmoid cells with lysis of the internal lining of the orbit in the chronic invasive form.



Figure 10: CT imaging, axial section, parenchymal window: Spontaneously hyperdense filling of cavities with lysis of the lateral wall of the sphenoid and endocranial extension in the chronic invasive form.



Figure 13: CT imaging, coronal, bone window: Filling heterogeneous pansinusien spontaneously hyperdense containing right of microcalcifications with orbital and intracranial extension in chronic invasive form.

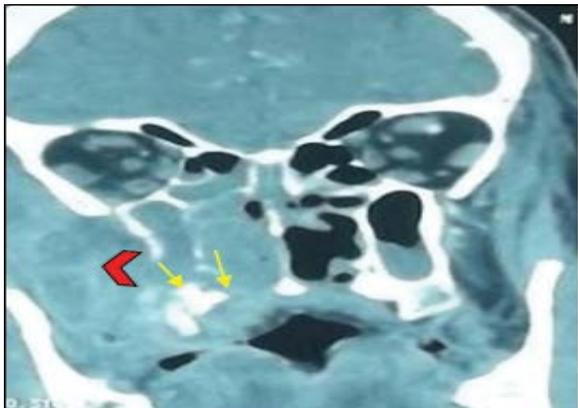


Figure 14: CT imaging, coronal section, in parenchymal window: Homogeneous filling of the ethmoid cells and the right maxillary sinus with lysis of all its walls with extension to the masticatory space, the dental arch and the retromaxillary region.



Figure 17: MRI, axial sections T1: Filling ethmoido maxillary right heterogeneous with central hypointense T1, T2 empty signal taking contrast in periphery with intra orbital and intracerebral extension.

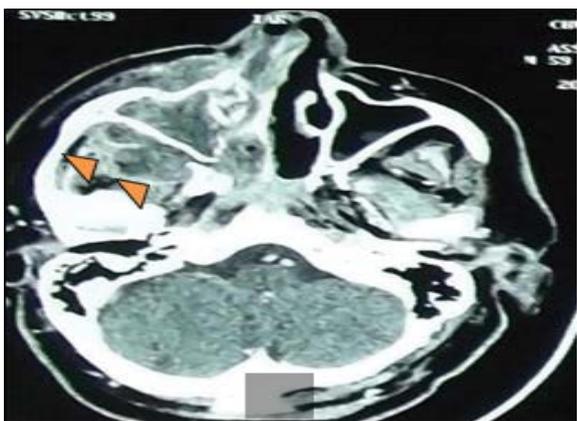


Figure 15: CT imaging, axial, in parenchymal window: Homogeneous filling of the ethmoid cells and the right maxillary sinus with lysis of all its walls with extension to the masticatory space, the dental arch and the retromaxillary region.

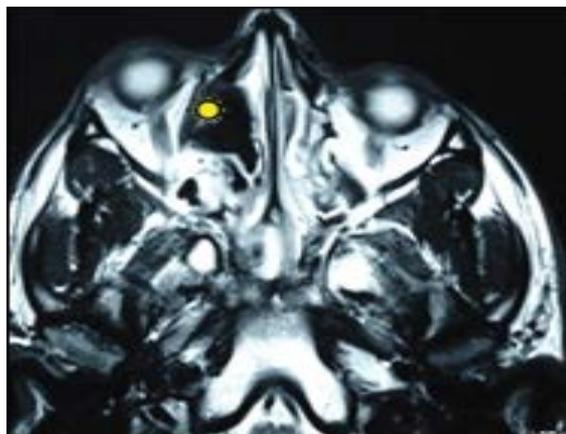


Figure 18: MRI, T2: Filling ethmoido maxillary right heterogeneous with central hypointense T1, T2 empty signal taking contrast in periphery with intra orbital and intracerebral extension.

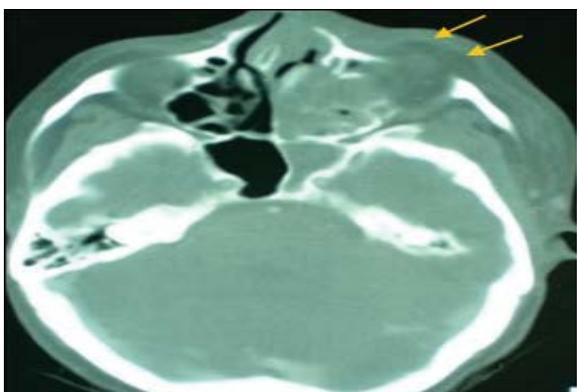


Figure 16: CT imaging, axial section, parenchymatous window: Filling homogeneous isodense the maxillary sinus, ethmoidal and sphenoidal left with an infiltration of the soft parts.

In the 3 cases of chronic invasive form, MRI was requested in front of a pansinusial filling with multiple bones lyses and endocranial extension in 2 cases (Figures 9-11), and an ethmoido-maxillary tissue filling extended to the nasal cavity with lysis of the intersinusoidal septum and nasal septum in one case. It showed a heterogeneous pansinusial filling in hypo or isosignal T1, T2 signal void very suggestive of fungal involvement (Figures 17 and 18) and confirmed the intracranial and orbital extension (Figures 19-21) in 2 cases.

In the case of the fungal ball, MRI was requested in the presence of non-specific left ethmoido-maxillary filling with lysis of the intersinusoidal septum at the CT associated with polypoid filling of the nasal cavity at the endoscopy in one case (Figure 4). It found an aspect of a complicated fungal graft and left maxillary mucocele (Figures 22 and 23).

MRI was performed in a case of mucormycosis with suspicion of thrombosis of the cavernous sinus and internal carotid artery. She confirmed this diagnosis by showing the thrombosis of the cavernous sinus associated with extensive thrombosis of the right internal carotid artery with an irregular appearance of the anterior and Sylvian ipsilateral communicating arteries (Figures 24 and 25).

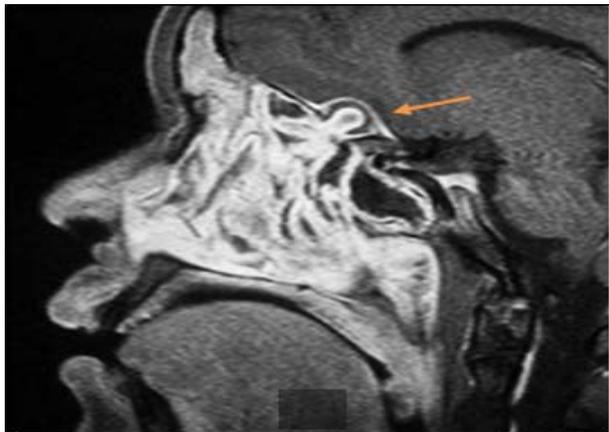


Figure 19: MRI, coronal section, in weighted T1 sequence after gadolinium injection: Pansinusien filling with intracerebral extension.

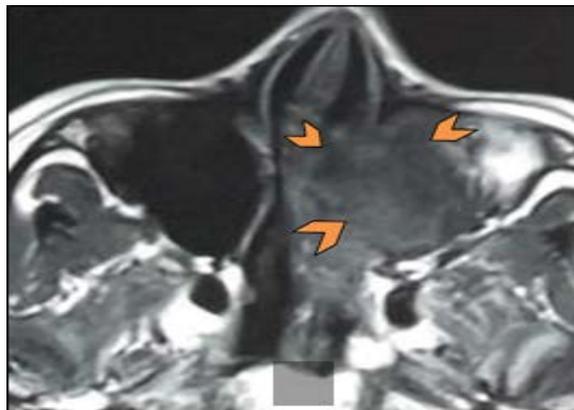


Figure 22: MRI, axial section T1 Appearance of fungal ball on MRI: Filling of the heterogeneous signal left signal T1, comprising a hyper T2 peripheral layer with an empty central signal zone.



Figure 20: MRI, sagittal section, in weighted T1 sequence after gadolinium injection: Pansinusien filling with intracerebral extension.

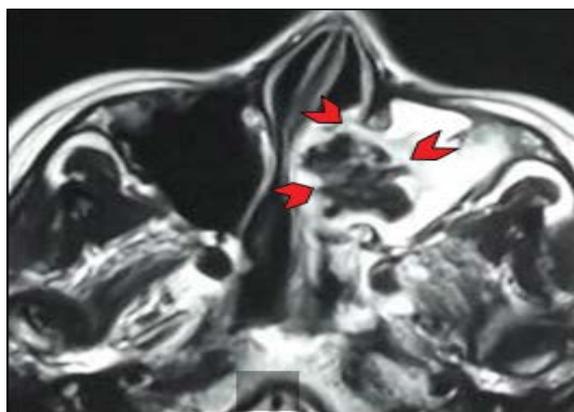


Figure 23: MRI, axial section T2 Appearance of fungal ball on MRI: Filling of the heterogeneous signal left signal T1, comprising a hyper T2 peripheral layer with an empty central signal zone.



Figure 21: MRI, injected coronal T1: Filling ethmoido maxillary right heterogeneous with central hypointense T1, T2 empty signal taking contrast in periphery with intra orbital and intracerebral extension.



Figure 24: MRI, coronal section in T1 weighting after gadolinium injection: Extensive filling of the right nasal fossa as well as straight nasal sinuses with palatal necrosis and continuity between the nasal cavity and the oral cavity associated with thrombosis of the cavernous sinus and right internal carotid artery.

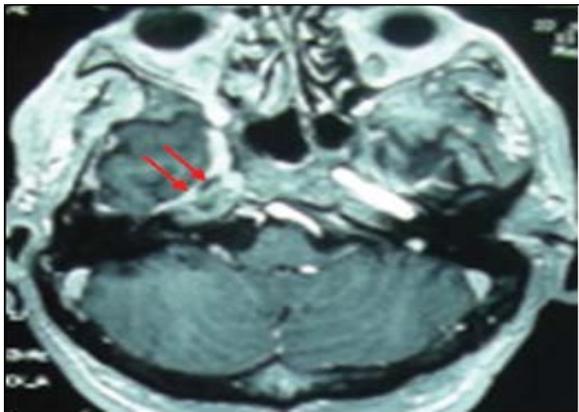


Figure 25: MRI, axial section in T1 weighting after gadolinium injection: Extensive filling of the right nasal fossa as well as straight nasal sinuses with palatal necrosis and continuity between the nasal cavity and the oral cavity associated with thrombosis of the cavernous sinus and right internal carotid artery.

All patients had surgical treatment. Functional endoscopic sinus surgery was performed in 24 patients. External approach was performed in one case in collaboration with neurosurgeons in a patient with orbital and endocranial extension. The Caldwell Luc pathway was performed in a single case of maxillary fungus bull operated in 1998. The paralateronasal route was performed in a case of mucormycosis with a massive extension to the soft tissues and intraorbital with hemiface necrosis. A mycological examination of intraoperative specimens was performed in 22 cases (12 cases of the fungal ball and all cases of the chronic and invasive form of the allergic form).

The direct examination was positive in 14 cases showing mycelial filaments in all cases. The culture was positive in 10 cases and isolated one *Aspergillus fumigatus* in 5 cases and one *Aspergillus flavus* in 5 cases. The appearance of friable and fetid blackish truffles was found in 21 patients. The presence of dental paste or calcium concretions was noted in 6 cases. An endoscopic appearance of allergic mucin was found in all five cases of the allergic form. Anatomic-pathological examination, performed in all cases, confirmed the diagnosis of allergic fungal sinusitis by showing mycelial filaments in 22 cases. In the remaining 4 cases, the diagnosis was retained on the result of the mycological study.

Pathological examination of allergic mucin revealed eosinophilic polynuclear cells in all cases and mycelial filaments in 3 cases. The crystals of charcot and leyden have not been objectified in any case. Invasion of the mucosa by the fungal agent with areas of ulceration was noted in 5 cases of chronic invasive fungal sinusitis. Because of the clinical suspicion of mucormycosis, the biopsy of the nasosinusal mucosa was made urgently with a mycological and histological study. The direct examination was positive in all cases thus allowing the identification of the fungal agent by showing mycelial filaments. Histological examination showed non-septal mycelial filaments.

Discussion

The diagnosis of fungal sinusitis is based on the association of suggestive clinical and paraclinical signs. The clinical picture is nonspecific. In addition to the clinical exploration, CT of the facial area, in axial and coronal sections, was performed in all our patients. The radiological signs varied according to the type of fungal attack. We have been able, through this study of 30 cases of fungal sinusitis, to

analyze the different radiological characteristics of these subgroups and to illustrate each form by a rich iconography. Computed tomography (CT), in axial and coronal sections, in bony and parenchymal windows, is the morphological examination of choice that must be performed as first-line treatment in the event of chronic sinusitis that is resistant to medical treatment [4-7]. This examination allows a strong diagnostic suspicion, a good analysis of the bone structures and a study of the invasion of the neighborhood organs.

In the literature, the fungal nature of sinusitis is evoked in front of [7-9] a heterogeneous, unilateral sinus filling, a metallic tonality image suggesting a foreign body, microcalcifications or spontaneously hyperdense plaques, a thickening of the bony walls of the sinus involved. According to Dhong [10], the presence of metallic opacity or microcalcifications within a filling of sinus cavities has a positive predictive value of 60% in fungal balls. However, it should be noted that these images of calcifications, although evocative, are not pathognomonic of fungal sinusitis because they can be seen in other pathologies [6]. The impact of the maxillary sinus is by far the most frequent, followed by isolated sphenoidal localization [6,7,9,11]. Bilateral forms are very rare [12]. We noted bone lysis in 3 cases. These images of bone lysis can be seen in the case of the fungal ball but are rare and most often localized. They are considered as signs related to the chronicity of sinusitis [6,7].

A heterogeneous filling with hypodense zones and hyperdense zones (double signal) containing calcifications were noted in 2 cases in our series. This aspect was suggestive of allergic fungal sinusitis in the presence of a particular clinical context. Indeed, this aspect is considered by some authors as pathognomonic of allergic fungal sinusitis [13]. For others, CT imaging is suggestive but not specific [14]. These hyperdensities, visible on non-injected sequences, are explained by the presence of allergic mucin whose composition is rich in protein and poor in water [15-17]. These same findings have been reported in different series [16,18]. Unilateral forms [19,20], as well as bilateral forms [5,21,22], have been reported. Bony deformities and erosions are found in 30 to 50% of cases [23,24], most commonly at the level of the ethmoidal sinus. These aspects have been found in all our patients. The exact mechanism responsible for this bone erosion is unclear [19]. According to Nussenbaum et al. [25], this fact can be explained by a hyper pressure on the bone walls stimulating their resorption or by the osteolytic action of certain enzymes secreted by the fungal agent. Extension to Perisinusian regions, orbit and / or endocranium is frequent at 20-50% [26,27]. For invasive fungal sinusitis, the radiological aspect is not specific. However, in a particular clinical context, they should be evoked in the presence of a multiple sinus lesion and especially if they are associated with orbital and/or endocranial involvement [28,29].

The most commonly found appearance is total filling or mucosal nodular thickening of the sinus cavities, usually unilateral with a predilection for the maxillary and ethmoidal sinuses followed by the sphenoid [5,21,28]. In our series, the involvement was pansinusal in 2 cases and ethmoido-maxillary in the other 2 cases. Bone lysis was noted in all cases. In addition to these signs, the infiltration of peri-maxillary fat is a very early sign that precedes bone lysis. Its presence makes it possible to suspect the diagnosis in front of any unilateral sinusitis on a weakened ground [15].

Complications are common. We noted in one case the thrombosis of the cavernous sinus associated with extensive thrombosis of the internal carotid artery. Posterior ethmoid or sphenoid involvement increases the risk of intracranial complications such as cavernous sinus thrombosis, internal carotid occlusion (13%) and brain abscess (12%).

This extension can be achieved in the absence of bone lysis by diffusion of the fungus *via* perivascular ducts [30].

A heterogeneous hyperdense filling with calcifications associated with bone lysis and orbital and endocranial invasion was noted in 2 cases among our patients with chronic invasive fungal sinusitis. This is the most frequently found aspect. Nevertheless, this CT appearance is nonspecific and can be confusing with a tumor process [5,15,31]. MRI is not indicated in the usual forms of chronic sinusitis. It finds its indications in invasive forms for studying of extension to neighboring organs (orbit, the base of skull, deep spaces of a face, cavernous lodge etc.) and for differential diagnosis with neoplasias [32,33].

The main and common feature of the various forms of *Aspergillus* sinusitis is the very hypointense aspect of the T2-weighted sequences which is due to the presence of ferromagnetic elements and essentially zinc in high concentration. Homogeneous enhancement is noted within the mass and its possible cerebral and orbital extensions after gadolinium injection. This enhancement is only annular in case of mass infected or necrotic center [34].

In allergic fungal sinusitis, the affected sinuses appear as central hyposignal in T1 and T2 weighted mode and as hyperintense mainly in peripheral T2 [13,15]. The contrast enhancement is mainly linear peripheral, sparing the center of the sinus. It corresponds to the inflammatory sinus mucosa. This aspect was noted in one case of our series. According to some authors, it allows this entity to be distinguished from other neoplasias [16]. The intracerebral extension is often limited and remains extradural.

In the literature, several studies have investigated the role of MRI in the early diagnosis of acute invasive sinusitis. Early in the disease process, imaging results can not be distinguished from those of common rhinosinusitis. Early signs that should suggest this diagnosis are the infiltration of fat from the retromaxillary region and soft tissues of the nasopharynx. Thanks to its high resolution in the study of soft tissues, MRI can demonstrate the first findings of fulminant fungal invasion with a negative predictive value of 60 to 100% [15]. It allows in the advanced stages to study the intraorbital and cerebral extension and to highlight the thromboses of the cavernous sinus, the internal carotid artery and its branches on the angiographic sequences [28,30,35].

In our study, MRI was performed in one case with suspicion of thrombosis of the cavernous sinus and internal carotid artery.

Conclusion

The presentations of fungal sinusitis on imaging are quite variable depending on its contents. Practicians should know the typical as well as atypical findings. Special care should be taken with regard to differential diagnosis.

Conflict of Interest

We declare that there is no conflict of personal interest incompatible with the objectives of this work.

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