J Surg Med. 2021;5(12):1214-1217.
DOI: 10.28982/josam.1024568

Journal of Surgery and Medicine
e-ISSN=2602-2079

Acute and chronic invasive fungal sinusitis and imaging features: A review

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Abstract

Fungal sinusitis is an infrequent disease that happens in immunosuppressed patients. Although acute and chronic invasive fungal sinusitis are pathologies with different clinical features and radiological imaging findings, mortality and morbidity rates are similarly high in patients. Therefore, early identification and offensive treatment are crucial. The use of diagnostic methods and the correct interpretation of imaging findings help to prevent fatal outcomes.

Keywords: Fungal sinusitis, Magnetic resonance imaging, Computed tomography

1. Introduction

1.1) Background

Inflammation of the paranasal sinuses (PNS) is called sinusitis. Sinusitis is most commonly caused by viral agents. Usually, the symptoms are mild and temporary (<4 week) [1]. Sinusitis with nonspecific symptoms and imaging findings for four weeks or longer is called chronic sinusitis [2]. An infrequent type of acute or chronic sinusitis is fungal sinusitis. Fungal sinusitis usually does not happen in people with normal immune functions [3]. However, chronic immunosuppression is one of the primary sinusitis factors that should be considered in people undergoing steroid use or malignancy treatment [4]. Fungal sinusitis can be divided into two groups as acute and chronic. However, its clinical progression is divided into invasive and non-invasive fungal sinusitis [5]. Invasive fungal sinusitis may result in destruction of mucosa, bone, adjacent neurovascular structures and surrounding soft tissues [6]. In this way, it may spread to the bone, intracranial structures, orbit and facial structures [7]. This study is aimed to review the imaging modalities and imaging findings of fungal sinusitis.

1.2) Imaging Methods

Computed tomography (CT) and magnetic resonance imaging (MRI) are performed to evaluate the presence of fungal sinusitis and its complications. CT is the first preferred method in the evaluation of fungal sinusitis [8, 9]. Non-contrast CT provides detailed bone structure visualization. Inflammatory secretions appear hypodense on CT. As the inflammatory process prolongs, the secretion density becomes more hypodense than the muscular structures. In addition, in the presence of fungal sinusitis, calcium salts accumulate in these secretions and appear hyperdense [10]. In addition, CT is very useful in determining the spread of fungal sinusitis to the intraorbital area and other compartments [11].

The soft tissue signal changes in MRI are based on the amount of protein in the contents of the sinuses, the viscosity of the content or the presence of calcifications. In fungal sinusitis with increased protein content, hypointense appearance on T1-weighted images and hypointense areas and/or loss of signal void can be observed on T2-weighted images [10]. MRI is better than CT in evaluating invasion and spread in adjacent tissues, including areas such as the orbit, intracranial compartment, vascular structures, neck and facial soft tissues, and pterygomaxillary fissure in fungal sinusitis [10]. MRI presents better soft tissue contrast resolution and is helpful in describing the spread of disease in more detail [12].

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Conflict of Interest
No conflict of interest was declared by the authors.

Financial Disclosure
The authors declared that this study has received no financial support.

Published
2021 December 20

How to cite: Bulut HT, Kaplan E, Çoraplı M. Acute and chronic invasive fungal sinusitis and imaging features: A review. J Surg Med. 2021;5(12):1214-1217.

2) Acute Invasive Sinusitis

Acute invasive fungal sinusitis is a fatal paranasal sinus infection caused by fungal factors in less than four weeks, occurring in immunosuppressed patients and uncontrolled diabetes patients [13, 14]. Zygomycetes type fungus such as Rhizopus, Mucor, Absidia are the most widespread reasons of invasive fungal sinusitis. Infections caused by these agents are called zygomycosis. It is frequently encountered in patients with diabetic ketoacidosis, patients receiving systemic chemotherapy, patients receiving steroid therapy, patients with hematological malignancies, and patients receiving immunosuppression therapy, such as after transplantation, and the mortality is high in these patients [13]. For this reason, the information provided by radiologists about the diagnosis and the complications that develop or may develop are very important in determining the treatment approaches of the clinicians.

2.1) Clinical features

In invasive fungal sinusitis, there are symptoms such as nasal congestion, facial pain, fever, nasal discharge and numbness that can be seen in other sinusitis rather than specific symptoms. Hematogenous spread is frequently observed with angioinvasion and epistaxis symptoms occur accordingly. The mucosa-submucosa is completely involved and ulceration and necrosis develop [15]. Depending on the degree of invasion and spread, intracranial and maxillofacial enlargement, visual disturbances, headache, and seizures may occur. Nasal cavity involvement occurs frequently [16].

2.2) Acute Invasive Fungal Sinusitis Imaging Features

Non-contrast CT particularly helps to evaluate the paranasal sinuses, nasal cavity and turbinates. The presence of mucosal thickening and soft tissue density at this level is the most common first CT imaging finding, though it isn't specific [17]. An unilateral involvement is observed in the ethmoid sinuses and especially in the sphenoid sinus. The maxillary and ethmoid sinuses are frequently affected, and the presence of full or partial soft tissue density in this sinus is a typical imaging feature (Figure 1A). One of the important factors that will indicate fungal infection is the presence of hyperdense areas in the soft tissue on CT.

The presence of these hyperdense areas specifically indicates vascular invasion. The structures to be evaluated in this type of invasive fungal sinusitis ought to be evaluated in the nasal cavity adjacent to the sinus, bone structures forming the nasal cavity and paranasal sinuses, structures next to the maxillary sinuses such as premaxillary and pterygopalatine fossa [14] (Figure 1B). The presence of erosion in bone structures is a marker for invasion, especially (Figure 1A-1B-1C). In addition, the presence of obliteration and enlargement in the periantral fatty tissue are very important (Figure 1A). This finding is an indication of intraorbital invasion and should be evaluated in patients with invasive fungal sinusitis [18].

MRI ought to be the first-choice imaging modality to detect bone erosion and visualize the orbital compartment, adjacent soft tissues and vascular structures, and the cavernous segment in case of periantral fatty tissue obliteration. The most important findings showing adjacent tissue invasion on MRI are the involvement of fatty tissue adjacent to the sinuses and signal changes similar to soft tissue on T1W images, and the presence of increased signal secondary to edema on T2-weighted images and the presence of enhancement in contrast-enhanced series (Figure 2B, Figure 2C). Contrast enhancement in the nasal mucosa, turbinates, and levels of soft tissue signaling is the typical finding of invasive fungal infection (Figure 2C). However, the absence of contrast enhancement in the turbinates in these areas where invasive soft tissue is evaluated is called the black turbinate sign and is a precursor of conchal necrosis [14] (Figure 2C). In orbital compartment imaging, signal changes in orbital fatty tissue and extraocular muscle groups and volume increase secondary to inflammation, prominence in retroorbital fatty tissue, and accordingly proptosis is indicators of intraorbital invasion [14] (Figure 2B). In the patient with these changes, the cavernous sinus and intracranial structures adjacent to the orbit should be evaluated rapidly (Figure 2A). Especially the presence of leptomeningeal enhancement, cerebritis, intracranial granuloma development should be evaluated. Intracranial well-circumscribed lesions with hypointense in T1W and T2W series that show minimal enhancement on contrast-enhanced images are indicative of intracranial granulomas.

Figure 1: 1A: CT images of a 46-year-old female patient. Soft tissue density filling the maxillary sinus: black arrow. Erosion of the posterior wall of the maxillary sinus and fullness of the periantral fat tissue: white arrow. Increase in skin thickness and decrease in edematous density: Red arrow. 1B: Soft tissue density filling the nasal cavity: Black Arrow. Bone density cannot be discerned due to invasion of the orbital lateral wall: White arrow. Soft tissue edematous changes in the anterior orbit: Red arrow. Bone structures secondary to invasion in the ethmoidal sinuses could not be discerned: White arrow

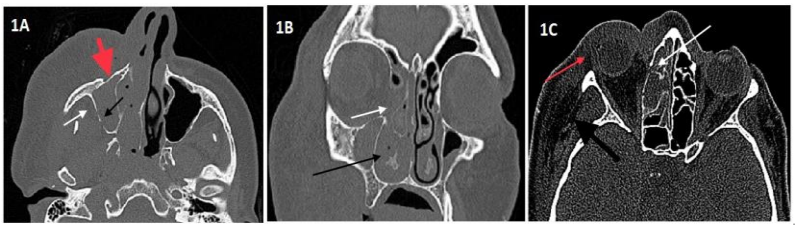
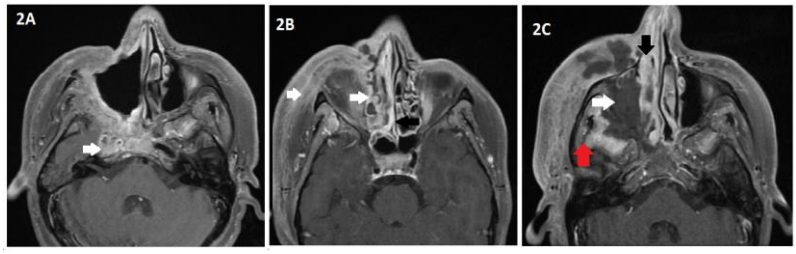


Figure 2: 2A: Contrast enhancement of internal carotid artery at the level of carotid canal on MRI T1W images: white arrow 2B: In a 46-year-old female patient, contrast enhancement in the bones in the conchae and nasal cavity with soft tissue invasion and enhancement in the adjacent soft tissue on MRI T1W contrast images: white arrows 2C: Areas of enhancement in the premaxillary area (red arrow) and nasal cavity (black arrow) and unenhanced areas secondary to soft tissue necrosis in the maxillary sinus cavity on MRI T1W images: White arrow



Thrombosis in the cavernous sinus, presence of thrombophlebitis, dissection in the cavernous artery segment and pseudoaneurysm are some of the advanced complications that can be observed due to the hematogenous spread and angioinvasion characteristics of fungal agents.

2.3) Treatment

Treatment in acute invasive fungal sinusitis is aggressive antifungal therapy and surgical debridement. However, it is very important to detect and control the situation that causes immunosuppression in the patient. Management and correction of this process in diabetic ketoacidosis patients affect the response to treatment. However, the mortality rate in acute invasive fungal sinusitis is 50-80%, and it is quite high despite all treatment methods [19].

3) Chronic Invasive Fungal Sinusitis

It is an inflammation caused by respiratory fungal agents in the sinuses between 4 and 12 weeks, andshows an angioinvasive structure just like the acute form by holding the mucosa, submucosa and bone structures. The process is slower than acute inflammation and can be limited. However, it is a significant reason of morbidity and mortality rates are high in case of delayed diagnosis and treatment [20].

3.1) Clinical features

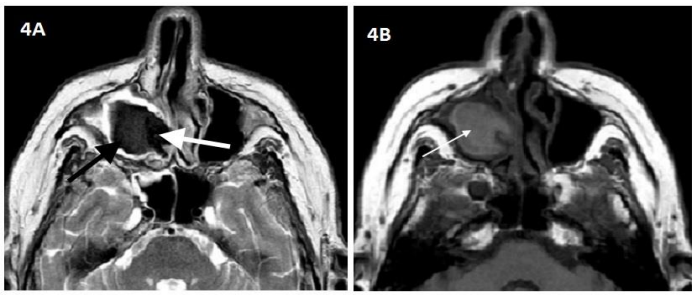
Individuals diagnosed with chronic fungal invasive sinusitis are also immunosuppressed and poorly controlled diabetes patients, just like those diagnosed with acute invasive fungal sinusitis. Symptoms include sinusoidal and facial pain, epistaxis, and fever. These symptoms are resistant to treatment. Orbital pain and limitation of motion in the orbit may also be observed in patients due to invasion into the orbital compartment. Polypoid mucosa may be observed and mass-like appearances may be present in the soft tissue on nasal examination [21].

3.2) Chronic Invasive Fungal Sinusitis Imaging Methods

Chronic invasive fungal sinusitis is less common than acute invasive fungal sinusitis [21]. Accurate diagnosis may not be made due to radiological variances [22, 23]. Therefore, the imaging features should be well known. The first preferred method in imaging for diagnosis should be CT without contrast. On imaging, findings are the same as acute invasive fungal sinusitis, with the presence of hypodense soft tissue density in the sinuses (Figure 3A). The destruction of the sinus wall and the mass appearance in this soft tissue and the expansion caused by the adjacent nasal cavity and structures are distinctive for chronic invasive fungal sinusitis (Figure 3A). One of the most important indicators of invasion is the presence of infiltration in the periantral soft tissue around the maxillary sinus [10]. In addition, as the process becomes chronic, hyperdense calcified areas can be detected within the defined mass soft tissue density (Figure 3A-3B). In MRI, soft tissue filling the sinus is seen as hypointense on T1-weighted images, while the signal may vary on T2-weighted images. Signal void loss of calcification in hypointense content can be observed in T2-weighted (Figure 4A-Figure 4B). Irregular bone destruction in the paranasal sinus walls and sclerotic changes in the affected sinus wall can also be seen on CT (Figure 3B). Due to the accumulation of calcium, a rough appearance is observed in the adjacent bone structures [24]. Irregularities and changes occur in adjacent tissues secondary to invasion. In this process, if no treatment is applied and immunosuppression is not controlled, extension to orbital structures, adjacent soft tissues and intracranial structures can be observed as in acute invasive sinusitis. Due to long-term invasive changes in the cavernous compartment, it may lead to complications such as mycotic aneurysm and cavernous sinus transformation in vascular structures [10].

Figure 3: 3A: Soft tissue density filling the maxillary sinus unilaterally: red arrow, calcified content in soft tissue density: thin white arrow; Bone structures in the medial wall of the maxillary sinus could not be distinguished due to invasion: thick white arrow 3B: Density increase of calcification in the anterior of the polypoid soft tissue mass filling the maxillary sinus: White arrow

Figure 4: 4A: In the MRI T2W image of a 67-year-old patient diagnosed with chronic invasive fungal sinusitis, increase in soft tissue thickness in the maxillary sinus, concentrated hypointense content (black arrow) and loss of signal void of calcification (white arrow). 4B: Maxillary soft tissue intensity with high viscosity on MRI T2W images: White arrow



3.3) Treatment

Surgical removal of infected tissues and the use of systemic antifungal agents are the main treatment. Although the process is chronic, aggressive treatment such as acute invasive fungal sinusitis should be applied especially in cases with intracranial compartment and cavernous sinus invasion due to high morbidity and mortality [19].

4) Conclusion

Fungal sinusitis is a significant clinical trouble with different symptoms and imaging findings. It ought to be taken in to consideration in the differential diagnosis in the presence of chronic sinusitis in diabetic patients, especially in immunosuppressed patients. In the presence of acute invasive fungal sinusitis, orbital and intracranial invasion often occur due to the rapid progression of complications, with the development of destruction and necrosis in the sinuses and nasal cavity. Although the imaging features in CT and MRI are more subtle initially, radiologists have a significant role in assessing the presence of invasion, especially in the early stages. In addition, it is important not only to diagnose, but also to show the spread of the disease and to recognize the findings of possible complications. Although chronic invasive fungal sinusitis differs from acute fungal sinusitis with its slow course, its symptoms and imaging findings are similar. If left untreated and undifferentiated, morbidity and mortality rates are as high as acute fungal sinusitis. It is especially important to distinguish it

from aggressive neoplastic lesions or benign soft tissue masses such as nasal polyps.

In order for radiologists to guide the clinician to the appropriate diagnosis and treatment, it is necessary to know the imaging findings of different types of fungal sinusitis and to evaluate possible complications with appropriate imaging methods. Early diagnosis and initiation of appropriate treatment are important to avoid a delayed and fatal outcome.

References

1. Fokkens WJ, Lund VJ, Mullol J, Bachert C, Alobid I, Baroody F, et al. EPOS 2012: European position paper on rhinosinusitis and nasal polyps 2012. A summary for otorhinolaryngologists. Rhinology. 2012 Mar;50(1):1-12. doi: 10.4193/Rhino12.000. PMID: 22469599.
2. Nocon CC, Baroody FM. Acute rhinosinusitis in children. Curr Allergy Asthma Rep. 2014 Jun;14(6):443. doi: 10.1007/s11882-014-0443-7. PMID: 24700347; PMCID: PMC7088858.
3. Bazan C 3rd, Rinaldi MG, Rauch RR, Jinkins JR. Fungal infections of the brain. Neuroimaging Clin N Am 1991;1:57–88.
4. Watkinson JC, Clarke RW. Scott-Brown's Otorhinolaryngology and Head and Neck Surgery: Volume 1: Basic Sciences, Endocrine Surgery, Rhinology; CRC Press: Boca Raton, FL, USA, 2018.
5. Montone KT. Pathology of Fungal Rhinosinusitis: A Review. Head Neck Pathol. 2016 Mar;10(1):40-6. doi: 10.1007/s12105-016-0690-0. Epub 2016 Feb 1. PMID: 26830404; PMCID: PMC4746136.
6. Watkinson, J.C.; Clarke, R.W. Scott-Brown's Otorhinolaryngology and Head and Neck Surgery: Volume 1: Basic Sciences, Endocrine Surgery, Rhinology; CRC Press: Boca Raton, FL, USA, 2018.
7. Reid JR. Complications of pediatric paranasal sinusitis. Pediatr Radiol. 2004 Dec;34(12):933-42. doi: 10.1007/s00247-004-1252-2. Epub 2004 Jul 27. PMID: 15278322.
8. Cornelius RS, Martin J, Wippold FJ 2nd, Aiken AH, Angtuaco EJ, Berger KL, et al. ACR appropriateness criteria sinonasal disease. J Am Coll Radiol. 2013 Apr;10(4):241-6. doi: 10.1016/j.jacr.2013.01.001. Epub 2013 Feb 16. PMID: 23420025.
9. Fatterpekar G, Mukherji S, Arbealez A, Maheshwari S, Castillo M. Fungal diseases of the paranasal sinuses. Semin Ultrasound CT MR. 1999 Dec;20(6):391-401. doi: 10.1016/s0887-2171(99)90023-9. PMID: 10634589.
10. Aribandi M, McCoy VA, Bazan C 3rd. Imaging features of invasive and noninvasive fungal sinusitis: a review. Radiographics. 2007 Sep-Oct;27(5):1283-96. doi: 10.1148/rg.275065189. PMID: 17848691.
11. Zeifer B. Pediatric sinonasal imaging: normal anatomy and inflammatory disease. Neuroimaging Clin N Am. 2000 Feb;10(1):137-59, ix. PMID: 10658159.
12. Iida E, Anzai Y. Imaging of Paranasal Sinuses and Anterior Skull Base and Relevant Anatomic Variations. Radiol Clin North Am. 2017 Jan;55(1):31-52. doi: 10.1016/j.rcl.2016.08.009. Epub 2016 Oct 25. PMID: 27890187.
13. Gillespie MB, O'Malley BW Jr, Francis HW. An approach to fulminant invasive fungal rhinosinusitis in the immunocompromised host. Arch Otolaryngol Head Neck Surg. 1998 May;124(5):520-6. doi: 10.1001/archotol.124.5.520. PMID: 9604977.
14. Groppo ER, El-Sayed IH, Aiken AH, Glastonbury CM. Computed tomography and magnetic resonance imaging characteristics of acute invasive fungal sinusitis. Arch Otolaryngol Head Neck Surg. 2011 Oct;137(10):1005-10. doi: 10.1001/archoto.2011.170. PMID: 22006778.
15. Yakirevitch A, Barg AA, Bedrin L, Primov-Fever A, Wolf M, Migirov L. Acute Invasive Fungal Rhinosinusitis in Children With Hematologic Malignancies: Outcome of Surgical Treatment. Pediatr Hematol Oncol. 2015;32(8):568-75. doi: 10.3109/08880018.2015.1092058. Epub 2015 Nov 11. PMID: 26558653.
16. Ni Mhurchu E, Ospina J, Janjua AS, Shewchuk JR, Vertinsky AT. Fungal Rhinosinusitis: A Radiological Review With Intraoperative Correlation. Can Assoc Radiol J. 2017 May;68(2):178-86. doi: 10.1016/j.carj.2016.12.009. PMID: 28438285.
17. DelGaudio JM, Swain RE Jr, Kingdom TT, Muller S, Hudgins PA. Computed tomographic findings in patients with invasive fungal sinusitis. Arch Otolaryngol Head Neck Surg. 2003 Feb;129(2):236-40. doi: 10.1001/archotol.129.2.236. PMID: 12578456.
18. Silverman CS, Mancuso AA. Periantral soft-tissue infiltration and its relevance to the early detection of invasive fungal sinusitis: CT and MR findings. AJNR Am J Neuroradiol. 1998 Feb;19(2):321-5. PMID: 9504486; PMCID: PMC8338170.
19. Craig JR. Updates in management of acute invasive fungal rhinosinusitis. Curr Opin Otolaryngol Head Neck Surg. 2019 Feb;27(1):29-36. doi: 10.1097/MOO.0000000000000507. PMID: 30585877.
20. Thompson 3rd GR, Patterson TF. Fungal disease of the nose and paranasal sinuses. J Allergy Clin Immunol. 2012;129(2):321–6.
21. Stringer SP, Ryan MW. Chronic invasive fungal rhinosinusitis. Otolaryngol Clin North Am 2000; 33(2):375–87.
22. Reddy CE, Gupta AK, Singh P, Mann SB. Imaging of granulomatous and chronic invasive fungal sinusitis: comparison with allergic fungal sinusitis. Otolaryngol Head Neck Surg. 2010 Aug;143(2):294-300. doi: 10.1016/j.otohns.2010.02.027. PMID: 20647138.
23. Gavito-Higuera J, Mullins CB, Ramos-Duran L, Sandoval H, Akle N, Figueroa R. Sinonasal Fungal Infections and Complications: A Pictorial Review. J Clin Imaging Sci. 2016 Jun 14;6:23. doi: 10.4103/2156-7514.184010. PMID: 27403401; PMCID: PMC4926542.
24. Yoon JH, Na DG, Byun HS, Koh YH, Chung SK, Dong HJ. Calcification in chronic maxillary sinusitis: comparison of CT findings with histopathologic results. AJNR Am J Neuroradiol. 1999 Apr;20(4):571-4. PMID: 10319962; PMCID: PMC7056005.

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