

Original Research Article

Diagnostic Radiological Imaging of Intracranial Complications of Sinusitis using CT Scan and MRI

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ABSTRACT

Background and Objectives: In the context of paranasal sinusitis, intracranial complications, though infrequent in the antibiotic era, can prove fatal. A substantial percentage of individuals may experience such complications, with a considerable fatality rate, often attributable to delayed disease diagnosis. Our study sought to evaluate the contribution of radiological diagnostics for the measurement and determination of the optimal timing for surgical intervention in patients with sinusitis complicated by intracranial issues.

Methodology: This study encompassed 50 patients diagnosed with chronic sinusitis accompanied by intracranial complications. Radiological examinations, including CT scans and MRI scans of the brain and paranasal sinuses, were performed. **Results:** CT and MRI scans were pivotal in detecting characteristic features indicative of infectious sinusitis, encompassing mucosal thickening, opacification of sinus cavities, soft tissue changes, and bone erosion. MRI emerged as the preferred imaging modality for delineating soft tissue involvement and discerning nuances in signal intensity, crucial for identifying necrotic tissue or extra cranial extension. Key imaging findings included mucosal thickening and variable signal intensities indicative of fungal masses in T1 as well as T2-weighted images, alongside contrast-enhanced MRI revealing patterns suggestive of tissue invasion. **Conclusions:** While CT is highly effective in imaging bone structures, the judicious use of MRI and Magnetic Resonance Venography (MRV), guided by clinical history and examination findings, is advisable to definitively exclude intracranial extension in cases of sinusitis.

Key Words: Sinusitis, Meningitis, CT Scan, MRI.

INTRODUCTION

Complicated sinusitis with intracranial involvement represents a rare yet very life-threatening phenomenon. An estimated 3% of sinusitis-related hospitalizations are associated with intracranial complications, marking a relatively low occurrence. Fortunately, the introduction of antibiotics has led to a decline in the mortality rate of this condition, which has continued to decrease in recent decades. In 1980, sinogenic subdural empyema carried a mortality rate of 40%. However, previous studies highlight a higher mortality rate, specifically a 50% fatality rate associated with these complications. Notably, non-specific signs or symptoms like fever and headache are usually the predominant initial manifestations, while neurological symptoms like focal neurological deficits and seizures also reported in patients (1-4).

In addition, there is the lingering concern of long-term neurologic complications, including seizures, aphasia and paresis. A systematic review, encompassing 16 studies, reported mean illness percent of 27%, emphasizing the importance of understanding the potential neurological consequences (3). Moreover, patients grappling with intracranial complications endure prolonged hospital admissions, with reported hospitalization durations reaching up to 40 days over the past decade. Timely recognition and prompt treatment are crucial, as any delay in addressing this condition can contribute to increased morbidity and mortality rates (5).

The primary objective for this investigation was to evaluate the contribution of radiological diagnostics for the measurement and determination of the optimal timing for surgical intervention in patients with sinusitis complicated by intracranial issues, aiming to enhance our understanding of effective management strategies.

MATERIAL AND METHODS

Our cross-sectional retrospective investigation was conducted at the Departments of Otolaryngology and Radiology of an Indian tertiary care hospital involving 50 cases afflicted with sinusitis complicated by intracranial involvement. The study encompassed a comprehensive evaluation of patient demographics, clinical manifestations, and radiological findings.

Patient assessment involved meticulous examination for sensory deficits, oral pathology including gangrenous changes or ulceration, and dental health, particularly in individuals with diabetes. Ophthalmic evaluations were conducted to assess visual function and identify associated complications such as optic nerve swelling or eye muscle paralysis.

Radiological investigations utilizing CT and MRI scans were pivotal in detecting characteristic features indicative of infectious sinusitis, encompassing mucosal thickening, opacification of sinus cavities, soft tissue changes, and bone erosion. MRI emerged as the preferred imaging modality for delineating soft tissue involvement and discerning nuances in signal intensity, crucial for identifying necrotic tissue or extracranial extension.

Patients presenting with suspected intracranial complications warranted urgent multidisciplinary intervention involving neurology, neurosurgery, and ophthalmology consultations tailored to individual comorbidities. Timely initiation of empirical intravenous antibiotic therapy formed the cornerstone of management, aimed at promptly diagnosing the condition and instituting appropriate treatment measures. Statistical analysis was conducted using IBM SPSS software, with significance levels set at $p < 0.05$.

RESULTS

The patient cohort (19 to 70 years) having an average age of 62.4 ± 11.34 , consisted of 13 males and 37 females (Table 1). Table 2 presents the intracranial complications in sinusitis cases observed in the study patients.

Among the cohort of patients under investigation, 6 individuals presented with abscess in temporal lobe. Clinical manifestations included facial pain, headache, nasal edema, nausea, obstruction, proptosis, and vomiting. Radiological assessment via CT of the brain and paranasal sinuses revealed pansinusitis, partially opacified sinuses, thickening of mucosa, diffuse bone destruction involving the skull base and alveolar margin, along with a vague hypodense lesion extending apically and intracranially. MRI of the brain indicated a well-defined abnormal signal intensity lesion within the temporal region without evidence of midline displacement (Table 3). All subjects underwent surgical intervention for tissue debridement, with abscess drainage performed by a neurosurgeon in the neurosurgery department. Regrettably, one patient died of the condition (mortality rate 17%).

Among the cohort of patients under investigation, there were 5 cases diagnosed with subdural empyema, characterized by symptoms such as fever, frontal manifestations, headache, nausea, personality changes, and vomiting, comprising 2 male and 3 female individuals. The radiological observations pertaining to these cases are detailed in Table 4. Surgical intervention involved the meticulous removal of diseased tissues through surgical debridement, with abscess drainage performed by a neurosurgeon in the neurosurgical department.

Furthermore, 4 patients within the study group presented with cerebellar abscesses, manifesting symptoms including chills, fever, headache, imbalance, nystagmus, seizure, vertigo, and vomiting, involving 2 male and 2 female subjects. The radiographic assessments for these cases are delineated in Table 5. Similarly, surgical management encompassed the thorough excision of afflicted tissues, with abscess drainage conducted by a neurosurgeon in the neurosurgical department. Regrettably, one patient succumbed to the condition.

Additionally, 3 patients exhibited frontal lobe abscesses associated with extradural inflammatory collections. Clinical manifestations included frontal headaches, low-grade fever, personality alterations, and vomiting. The corresponding radiological discoveries are shown in Table 6. Surgical debridement was done in all subjects for lesion removal, with abscess drainage performed by a neurosurgeon in the neurosurgical department. Tragically, one patient experienced a fatal outcome.

Table 1: Demographic characteristics of study patients

Parameter	n	%
Age in years, (mean±SD)	62.4 ± 11.34	
Gender		
Female	37	74.00
Male	13	26.00

Table 2: Intracranial complications of sinusitis in study participants

Intracranial Complication	n	%
Meningitis	12	24.00
Cavernous sinus thrombosis	10	20.00
Frontal lobe or orbital cellulitis	8	16.00
Temporal lobe abscess	6	12.00
Subdural empyema	5	10.00
Cerebellar abscess	4	8.00
Frontal lobe abscess with extradural inflammatory abscess	3	6.00
Epidural abscess	1	2.00

Osteomyelitis of the skull	1	2.00
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Table 3: Radiological findings in Temporal Lobe Abscess

Radiological Finding	n	%
CT PNS and Brain		
Pansinusitis	6	100.00
Mucosal thickening	6	100.00
Partially opacified sinuses	5	83.33
Diffuse bony erosion with invasion of skull base and alveolar margin	4	66.67
Ill-defined hypodense lesion with apical and intraconal extension	3	50.00
MRI Brain		
Well defined temporal lesion with abnormal signal intensity	6	100.00
No midline shifting	5	83.33

Table 4: Radiological findings in subdural empyema

Radiological Finding	n	%
CT PNS		
Mucosal thickening in frontal sinus (Bilateral)	5	100.00
Mild central septal deviation	4	80.00
CT Brain		
Right side Low density lesion with peripheral enhancement	4	80.00
Left side Low density lesion	1	20.00
MRI Brain		
left frontal lobe involvement along with subdural extension (ill-defined hypodense lesion)	5	100.00

Table 5: Radiological findings in cerebellar abscess

Radiological Finding	n	%
CT PNS		
Totally obliteration in ethmoid and sphenoid sinus	4	100.00
Septal deviation	3	75.00
Ill-defined margins, Hypodense lesion, in maxillary sinus.	4	100.00
CT Brain		
Lesion showing low density and peripheral enhancement in Right cerebellum	3	75.00
Lesion showing low density and peripheral enhancement in Left cerebellum	1	25.00
MRI Brain		
Mass lesion in right cerebellum (high T2 signal intensity in center, thin regular rim of contrast at periphery)	3	75.00
Mass lesion in left cerebellum (high T2 signal intensity in center, thin regular rim of contrast at periphery)	1	25.00
Diffusion with central restriction	4	100.00

Table 6: Radiological findings in frontal lobe abscess

Radiological Finding	n	%
CT PNS and Brain		
Bilateral obliteration of ethmoid, frontal, maxillary and sphenoid sinuses	3	100.00
Bilateral abnormal edema in brain parenchyma in frontal lobes	3	100.00
Hypodense frontal lobe lesion with Ill-defined margins	2	66.67
Deficient nasal septum, medial wall of maxilla and middle turbinate	2	66.67
MRI Brain		
Intracranial supraorbital collection with epidural hyperintensity	3	100.00

DISCUSSION

In the present investigation, 12 patients were diagnosed with meningitis, with a mean age of 38 years. Their clinical presentation included convulsions, fever, and headache. CT scans revealed sphenoidal sinusitis with mucosal thickening, while MRI depicted leptomeningeal enhancement, subarachnoid space distention, and widening of the interhemispheric fissure. Sinusogenic bacterial meningitis was identified as an acute purulent infection within the subarachnoid space, leading to inflammatory meningeal reactions, impaired consciousness, epileptic seizures, and increased intracranial pressure (6). Focal neurological symptoms prompted the use of MRI to detect central nervous system lesions, with milder meningitis courses observed when accompanied by other intracranial complications.

In another segment of the study, patients with temporal lobe abscesses exhibited CT findings of pansinusitis, partially opacified sinuses, mucosal thickening, diffuse bone erosion invading the alveolar margin and skull base, and ill-defined hypodense lesions with apical and intraconal extensions. MRI revealed ill-defined abnormal signal intensity lesions in the temporal lobe without midline shifting. Wax et al. (7) reported a case of headache, confusion, and seizures following antibiotic treatment for sinusitis, with CT and subsequent MRI confirming a left temporal lobe abscess. Two cases of subdural empyema were also identified, characterized by CT findings of obliterated ethmoidal and sphenoidal sinuses, septal deviation, and ill-defined hypodense lesions in the maxillary sinus. MRI depicted abnormal ill-defined hypodense lesions in the left frontal lobe with subdural extension, accompanied by clinical symptoms such as fever, nausea, vomiting, headache, and frontal manifestations. Clinical features of subdural empyema included persistent fever despite meningitis treatment, focal seizures, increased intracranial pressure symptoms, and occasionally stroke-like presentations. MRI typically revealed bright areas in diffusion-weighted images due to underlying edema. Subdural empyema often originates from frontal sinusitis or spreads from epidural empyema. The rapid evolution of this complication underscores its severity, with the subdural space providing minimal barriers to infection spread. Contrast-enhanced CT or MRI aids in diagnosing sinusogenic intracranial empyema, with non-enhanced CT alone insufficient for diagnosis (8-11). Sinusogenic brain abscesses, primarily frontal and parietal, constitute focal cerebral tissue infections, comprising a smaller proportion compared to otogenic abscesses but often more severe. The clinical course varies, with common symptoms including headache, low-grade fever, neurological deficits, epileptic episodes, personality changes, impaired consciousness, and contralateral hemiplegia in

deeper, diffuse abscesses. MRI is superior to CT in early abscess detection, revealing enhancing capsules surrounding hypodense centers amidst brain edema (12-15).

CONCLUSION

While CT Scan remains invaluable for assessing bony structures, the judicious application of MRI and Magnetic Resonance Venography (MRV) is advised, particularly guided by clinical history and examination findings, to conclusively exclude intracranial extension in cases of sinusitis.

REFERENCES

1. Patel AP, Masterson L, Deutsch CJ, et al. Management and outcomes in children with sinogenic intracranial abscesses. *Int J Pediatr Otorhinolaryngol.* 2015;79(6):868-873.
2. Kou YF, Killeen D, Whittemore B, et al. Intracranial complications of acute sinusitis in children: the role of endoscopic sinus surgery. *Int J Pediatr Otorhinolaryngol.* 2018;110:147-151.
3. Patel NA, Garber D, Hu S, Kamat A. Systematic review and case report: intracranial complications of pediatric sinusitis. *Int J Pediatr Otorhinolaryngol.* 2016;86:200-212.
4. Din-Lovinescu C, Mir G, Blanco C, Zhao K, et al. Intracranial complications of pediatric rhinosinusitis: identifying risk factors and interventions affecting length of hospitalization. *Int J Pediatr Otorhinolaryngol.* 2020;131:109841.
5. Schupper AJ, Jiang W, Coulter MJ, et al. Intracranial complications of pediatric sinusitis: identifying risk factors associated with prolonged clinical course. *Int J Pediatr Otorhinolaryngol.* 2018;112:10-15.
6. Sivaswamy L, Ang J. Intracranial complications of sinusitis. *J Pediatr.* 2018;195:306.
7. Wax JR, Blackstone J, Mancall A, et al. Sinogenic brain abscess complicating pregnancy. *Am J Obstet Gynecol.* 2004;191(5):1711-1712.
8. Yong A, Gomati A, Khor K, KheiHu M, et al. Complications of Acute Sinusitis: A Review and Case Series. *Open Access J Neurol Neurosurg.* 2020;14(3):555888. DOI: 10.19080/OAJNN.2020.14.555888.
9. Bruner D, Littlejohn L, Pritchard A. Subdural Empyema presenting with seizure, confusion and focal weakness. *West J Emerg Med.* 2012;13:509-11.
10. Adame N, Hedlund G, Byington CL. Sinogenic intracranial empyema in children. *Pediatrics.* 2005;116(3):e461-e467.
11. Zakrzewski A. Nieżytytnosa, stany zapalne zatok przynosowych i ich powikłania. In: *Otolaryngologia kliniczna.* Red. A. Zakrzewski. PZWL; 1984:77-93.
12. El Ahl MAASAE, Elsamak AAAE, Elharam NY, Elsayed AI. Radiological Diagnosis of Intra-Cranial Complication of Sinusitis. *J Cardiovasc Dis Res.* 2021;12(4):2161-2170.
13. Roos KL, Tyler KL. Zapalenie opon mózgowo-rdzeniowych, zapalenie mózgu, ropień mózgu i ropniak mózgu. In: *Harrison. Choroby zakaźne.* Red. Kaspara DL, Fauciego AS. Wyd. Polskie; 2012:398-440.
14. Szyfter W, Kruk-Zagajewska A, Borucki Ł. Wynik leczenia 101 usznopochodnych ropni mózgowia. *Otolaryngol Pol.* 2011;65:88-96.

15. Tandon S, Beasley N, Swift AC. Changing trends in intracranial abscesses secondary to ear and sinus disease. *J Laryngol Otol.* 2009;123:283-288.