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A Case Report of Frontal Sinus Abscess Complicated by Epidural Abscess with a Literature Review

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Abstract: Inflammation of the frontal sinus is a relatively common clinical condition among paranasal sinusitis and is curable through anti-infection treatments, with a rare progression to frontal sinus abscess. An even rarer complication is the development of intracranial epidural empyema secondary to frontal sinus abscess. In this report, we describe a case of a 14-year-old male with a frontal sinus abscess that led to intracranial infection and was complicated by an epidural abscess misdiagnosed as an epidural hematoma. The primary symptoms were headache, dizziness, and fever. Following combined antibiotic therapy and surgical intervention, including maxillary and frontal sinus window drainage, the patient was cured. A follow-up period of three months showed no recurrence, indicating a favorable outcome.

Keywords: sinusitis, frontal sinus abscess, intracranial infection, epidural abscess

Introduction

Sinusitis is defined as the inflammation of the nasal and paranasal sinus mucosa.[1] It can be caused by bacterial infection, mucociliary clearance (MCC) dysfunction, disruption of the epithelial barrier, interruption of the immune response, microbial biofilm communities, and dysbiosis of the sinus microbiota, among other factors.[2] Frontal sinus abscess primarily results from untreated or inadequately treated paranasal sinus inflammation and can lead to severe intracranial complications through direct invasion or retrograde thrombophlebitis, such as meningitis, epidural abscess, and subdural abscess.[3] Although these complications are rare, they can be life-threatening once they occur. This report presents a case of frontal sinus abscess secondary to intracranial infection, complicated by an epidural abscess misdiagnosed as an epidural hematoma, and summarizes the relevant literature from both domestic and international sources for discussion, aiming to further enhance the understanding of the disease and reduce misdiagnosis and missed diagnosis.

Case

The patient is a 14-year-old male who was admitted to a local hospital due to headache and dizziness accompanied by fever and a runny nose for 1 week. Cranial CT showed bilateral frontal epidural hemorrhages, and the local hospital initially diagnosed an intracranial epidural hematoma. However, after symptomatic supportive treatment, the patient's headache and fever progressively worsened, and he was referred to our hospital as an emergency case. He had a history of upper respiratory tract infection two weeks earlier. Physical examination: conscious, depressed, severe headache, swelling of the forehead, soft to touch, obvious fluctuating sensation, and positive signs of meningeal irritation. Emergency cranial CT revealed a right frontal epidural effusion with pneumatization, along with effusions in the right maxillary, ethmoid, and frontal sinuses, indicating the presence of multiple groups of paranasal sinusitis (Figure 1A). The

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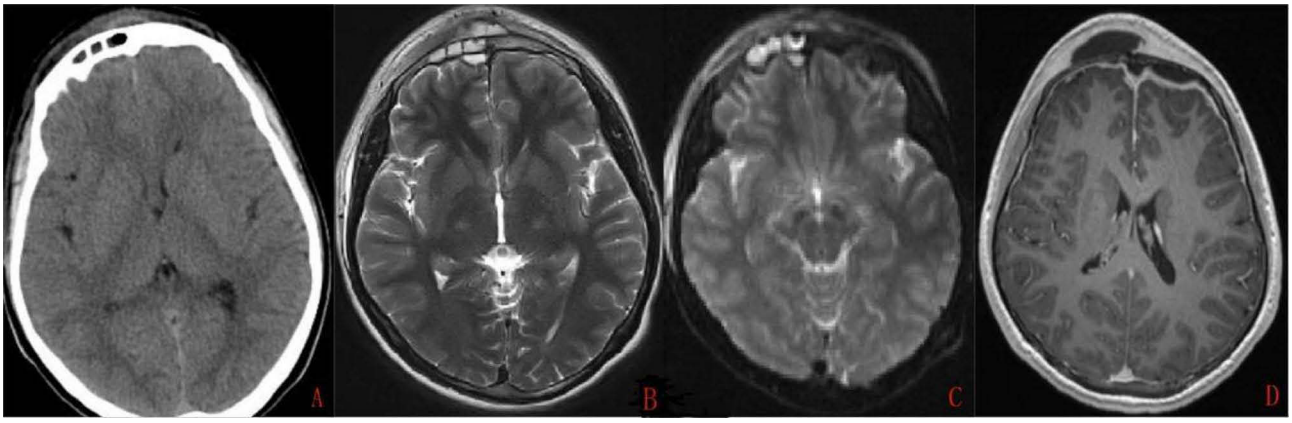

Figure 1 (**A**) right frontal epidural effusion with gas accumulation, frontal subcutaneous soft tissue swelling; (**B-D**) MRI: A crescent-shaped, spindle-shaped long T2 signal shadow was observed beneath the right frontal cranial plate, along with swelling of the frontal scalp soft tissue; Subcutaneous small patchy long T2 signal shadow and a small amount of gas accumulation shadow were also noted; DWI showed a slightly high signal, and scattered gas shadows were also observed beneath the cranial plate; The subcutaneous lesion was communicating with the right frontal sinus and frontal subcranial plate lesion.

main laboratory results are shown in (Table 1). Blood culture results showed Staphylococcus aureus infection, and drug sensitivity tests indicated sensitivity to vancomycin, cephalosporins, and linezolid. Combined with the patient's medical history, physical examination, and auxiliary examinations, the preliminary diagnosis is: 1. multiple groups of paranasal sinus abscess 2. possible intracranial infection 3. possible bacteremia. The patient's condition is critical. After discussion among the treatment team, he was temporarily administered ceftriaxone sodium 1g q12h and vancomycin hydrochloride 0.75g q8h intravenously (IV) for combined anti-infective treatment. After 2 days of treatment, the patient's temperature gradually improved, however, the symptoms of headache and pus drainage remained unresolved. Further cranial MRI examination suggested the following findings: mucosal thickening of the right paranasal sinuses, with the sinus cavity filled with a long T2 signal shadow; a crescent-shaped, spindle-shaped long T2 signal shadow was observed below the right frontal cranial plate, accompanied by swelling of the frontal scalp soft tissue, subcutaneous small patchy long T2 signal shadow, and a small amount of gas shadow; DWI revealed a slightly elevated signal, and scattered gas shadows were also observed beneath the cranial plate. Additionally, a subcutaneous lesion was noted in association with the right

Table 1 Main Laboratory Results

Project Title	Result	Reference Interval	Unit
White cell count	15.7↑	4.1–11.0	109/L
Neutrophil %	87.70↑	37–77	%
C-reactive protein	302.32↑	0–6	mg/L
Homocysteine	19.87↑	<15	umol/L
Cerebrospinal fluid chloride	115.69↑	118.0–132.0	mmol/L
Cerebrospinal fluid glucose	3.48	2.8–4.5	mmol/L
Total cerebrospinal fluid protein	0.66↑	0.15–0.45	g/L
IL-6	17.37↑	<7	pg/mL
Calcitoninogen	0.106↑	<0.065	ng/mL
Blood culture	Staphylococcus aureus		
Drug sensitivity testing	Levofloxacin, Vancomycin, linezolid antibiotic sensitivity. Penicillin, Erythromycin, Clindamycin antibiotic resistance		

frontal sinus, and this lesion appeared to be connected to the area beneath the frontal cranial plate (Figure 1B–D). After consulting and discussing with the otorhinolaryngology department of our hospital, it was decided to perform open drainage of the maxillary sinus and frontal sinus under general anesthesia with the assistance of nasal endoscopy. During the operation, purulent secretions were observed in the sinus cavities of the maxillary sinus and frontal sinus. These secretions were repeatedly rinsed out with physiological saline and suctioned. The openings of the maxillary sinus and frontal sinus were dilated, and the operation was successfully completed (Figure 2). After the operation, the swelling of the forehead improved significantly. The patient continued to receive vancomycin hydrochloride injection (0.75g q8h) and meropenem for injection (1g q8h) for anti-infective treatment, along with nutritional support therapy, for 1 week. During this time, the body temperature returned to normal, the headache disappeared, and inflammatory markers such as leukocytes, neutrophils normalized and C-reactive protein were normal, After continuing the consolidation therapy for 1 week, he was discharged from the hospital. After discharge, the patient was advised to continue taking linezolid tablets 0.6g qd for 1 month. The patient was followed up for 3 months, with no new onset of symptoms, and no recurrence of frontal sinus, maxillary sinus, and epidural abscesses on repeat cranial MRI (Figure 3).

Discussion

Sinusitis is defined as inflammation of the mucous membranes of the nasal cavity and paranasal sinuses.[1] Among these, inflammation of the frontal sinuses, a form of sinusitis, is the most common cause of intracranial complications related to paranasal sinus inflammation.Inflammation of the frontal sinuses, which is closely associated with numerous crucial anatomical structures, can result in a range of potentially life-threatening complications if left untreated. For example, In the anatomical relationship between the frontal sinus and the orbit, since the base of the frontal sinus lies directly above the orbit, an extension of infection can potentially result in corresponding orbital complications through either direct invasion or retrograde thrombophlebitis,[4] These complications include nasal septal cellulitis, orbital cellulitis, subperiosteal abscess, and orbital abscess. Further extension of the infection into the middle cranial fossa may result in intracranial complications such as meningitis, epidural abscess, subdural abscess, brain abscess, and cavernous sinus thrombosis, all of which can pose a life-threatening risk to the patient.[3] Recent studies have shown that epidural abscesses are a more common intracranial complication of inflammation of the frontal sinuses and are infections in the epidural cavity anywhere in the brain.[5] The majority of intracranial epidural abscesses occur in children or

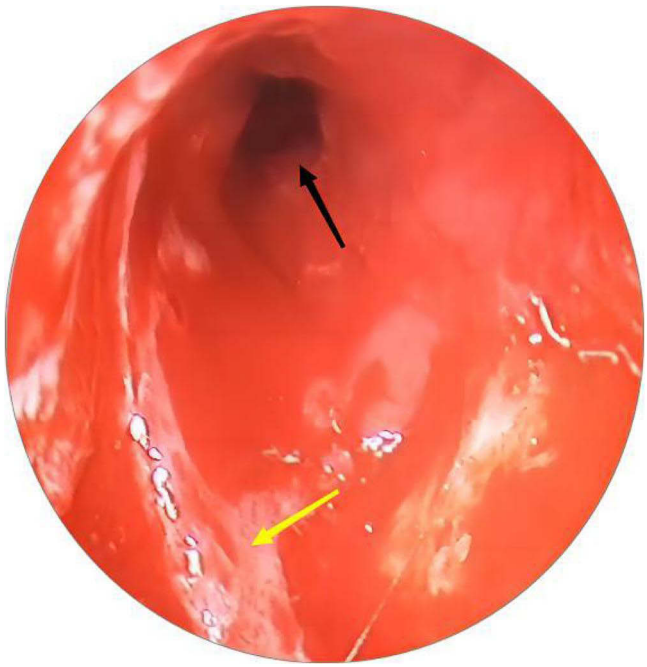

Figure 2 The frontal sinus opening (black arrow) and pus (yellow arrow) are shown in the figure.

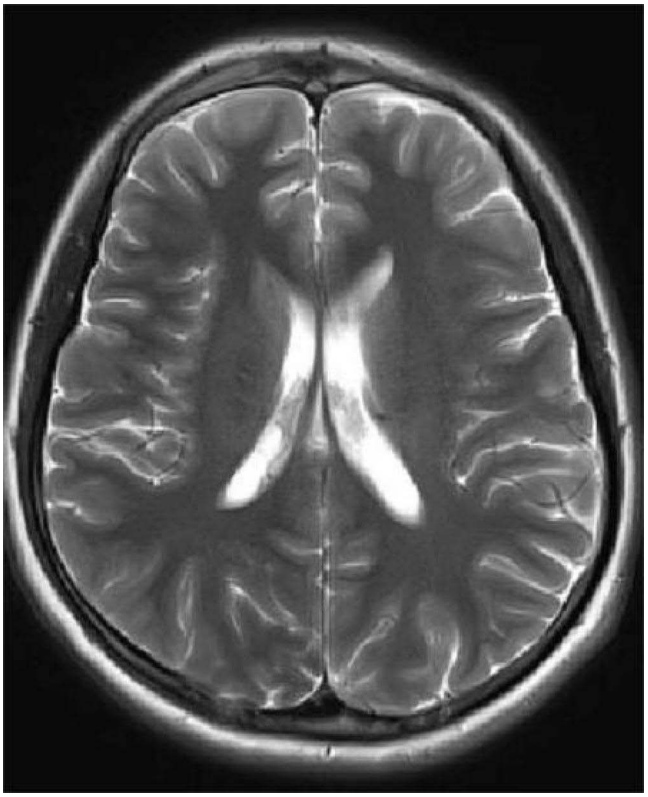

Figure 3 Cranial MRI of the patient in the third month after surgery: bilateral frontal epidural effusions were not shown, original frontal scalp soft tissue swelling was not shown, and the patient recovered well.

adolescents, with over 70% of patients being younger than 20 years of age.[6] The most common signs and symptoms are headache, fever, vomiting, altered mental status, seizures, mild hemiparesis or cranial nerve signs.[7] Peripheral blood leukocytosis is the most common laboratory abnormality in intracranial epidural abscesses.[8] In this regard, we conducted a literature review on PubMed, using the keywords 'sinusitis', "frontal sinus inflammation", and "epidural abscess", resulting in the retrieval of 31 similar cases (Table 2). More than 50% of the patients exhibited inflammation of the frontal sinuses. Notably, 26 patients, constituting 83.87%, were aged 20 years or younger. Furthermore, 80.65% of the patients were male. Almost all patients presented with headache and fever, while other symptoms included dizziness, vomiting, diarrhoea, and epilepsy. Most of the infections were bacterial, with Streptococcus spp. being the predominant species, accounting for over 50% of the total cases. Staphylococcus spp. and Haemophilus influenzae were also identified, while a small number of cases presented with mixed infections involving multiple pathogenic microorganisms. A single case of fungal infection was also observed.[9] Following a combination of antibiotic and surgical treatment, most patients achieved favorable outcomes.

In this case, due to untreated inflammation of the frontal sinus, the patient developed frontal sinus pus accumulation, subcutaneous abscess in the forehead region, and intracranial epidural effusion. The patient exhibited persistent hyperthermia, and blood culture tests revealed a positive result for Staphylococcus aureus infection. A review of pertinent data has identified the primary causative organisms of acute sinusitis to be Streptococcus pneumoniae, Haemophilus influenzae, Moraxella catarrhalis, and Staphylococcus aureus. However, the principal species causing intracranial complications of sinusitis are Streptococcus species, Staphylococcus species, and anaerobes.[9] The patient presented to the hospital with early symptoms of headache, dizziness, and fever. Upon arrival, a physical examination revealed a positive meningeal irritation sign. Subsequent laboratory tests indicated a significant elevation in the patient's white blood cell count. CT is often the first choice for the diagnosis of sinusitis with intracranial complications for the sake of easier access and rapid diagnostic needs.[31] Compared to CT, MRI is equally good at detecting sinus disease, and MRI is more sensitive in diagnosing complications such as meningitis and intracranial abscesses.[32] Younis et al analysed

Table 2 Summary of Cases of Epidural Abscess Secondary to Sinusitis

No.	Patients Characteristics		Symptom	Source of Infection	Antibiotics	Surgical Procedure	Conclusion	Reference
	(Age)	(Sex)						
1	16	M	Headache, fever.	Alpha hemolytic streptococcus.	Nafcillin, gentamicin, Chloramphenicol.	/	Well	[10]
2	20	F	Headache, fever.	Bacteroides fragilis.	/	Surgical exploration of the right frontal sinus.	Well	[11]
3	33	M	Headache, fever.	Staphylococcus.	/	Drainage of abscesses by drilling holes.	Well	[12]
4	14	M	Headache, fever.	Beta-haemolytic Streptococci, Haemophilus influenzae.	Cefotaxime, metronidazole, Amoxycillin.	/	Well	[8]
5	11	M	Headache, fever.	Streptococcus milleri.	Penicillin G, Amoxycillin.	/	Well	[8]
6	15	M	Headache, fever.	Staphylococcus aureus.	Flucloxacillin	/	Well	[8]
7	11	M	Frontal headaches, fever.	Streptococcus intermedius	Ampicillin, nafcillin, Chloramphenicol	Bilateral frontal sinus trephinations	Well	[13]
8	7	M	Headache, vomiting, fever.	/	Cefotaxime, oxacillin, vancomycin.	Right frontal sinusotomy, ethmoidectomy, middle meatal antrostomy.	Well	[14]
9	10	M	Flu-like symptoms.	Anaerobic streptococci, Haemophilus parainfluenzae.	Imipenem-cilastatin, Fosfomycine.	Midfrontal craniotomy.	Well	[15]
10	19	M	Fever, rhinorrhea, sore throat, and headache	Staphylococcus aureus.	Piperacillin, clindamycin Roxithromycin.	Endoscopic drainage through the frontal sinus, endoscopic sinus surgery.	Well	[16]
11	18	M	Headache, fever	Microaerophilic streptococcus.	Ceftriaxone, metronidazole.	Bifrontal craniotomy.	well	[17]
12	29	F	Headache	Staphylococcus aureus.	/	Frontal craniotomy	well	[18]
13	44	M	Headache, blackout spell	/	/	Bifrontal craniotomy	Well	[18]
14	13	M	Headache, vomiting, fever.	Streptococcus pneumoniae	Vancomycin, Ceftriaxone.	Endoscopic nasal surgery	Well	[19]

(*Continued*)

Table 2 (Continued).

No.	Patients Characteristics		Symptom	Source of Infection	Antibiotics	Surgical Procedure	Conclusion	Reference
	(Age)	(Sex)						
15	19	M	Periorbital painful swelling, headache and vomiting.	/	/	Operated upon via a coronal incision with bifrontal access to both abscess.	Well	[20]
16	8	M	Fever, facial swelling	Staphylococcus aureus	/	Medial supraorbital craniotomy through an incision in the eyebrow.	Well	[21]
17	11	F	Headache, fever	Staphylococcus aureus, Alpha hemolytic streptococci, Prevotella intermedia.	Cefotaxime, vancomycin, Metronidazole.	Functional endoscopic sinus surgery.	Well	[22]
18	31	M	Headaches, fever	Group F Streptococcus, microaerophilic Streptococcus, coagulase negative Staphylococcus.	Cefuroxime, metronidazole.	Bilateral endoscopic sinus surgery.	Well	[23]
19	14	M	Headaches, fever	Streptococcus viridans.	Ceftriaxone, metronidazole.	Bilateral endoscopic sinus surgery.	Well	[23]
20	14	M	Headaches, frontal facial pain	/	/	Frontal sinusotomy.	Well	[23]
21	10	F	Headaches, fever	Nutritionally variant Streptococcus.	Clindamycin, ceftriaxone, metronidazole.	Bilateral ethmoidectomies, maxillary antrostomies, frontal sinusotomies, left sphenoidotomy.	Well	[23]
22	13	M	Headaches, fever	/	Vancomycin, ceftriaxone.	Percutaneous tapping.	Well	[24]
23	13	M	Headaches, fever	Streptococcus intermedius	/	/	Well	[25]
24	10	F	Fever, headache, frontal swelling	Alpha-hemolytic Streptococci, Staphylococcus aureus.	Meropenem, cephalexin.	Left-sided frontal craniotomy, evacuation of the epidural empyema, left maxillary antrostomy, and left anterior ethmoidectomy.	Well	[26]
25	13	M	Headache, fever	/	/	/	Well	[27]

(*Continued*)

Table 2 (Continued).

No.	Patients Characteristics		Symptom	Source of Infection	Antibiotics	Surgical Procedure	Conclusion	Reference
	(Age)	(Sex)						
26	53	M	Headache, fever	Filamentous fungal.	Ceftriaxone, clindamycin, vancomycin, meropenem.	Craniotomy and endoscopic sinus fenestration.	Well	[9]
27	9	M	Headache, fever	/	/	Bifrontal craniotomy.	well	[28]
28	13	M	Headache, somnolence	Streptococcus anginosus, Eikenella corrodens.	Vancomycin, cefepime, metronidazole.	Medial eyebrow approach with concurrent frontal sinus trephination.	Well	[29]
29	16	M	Headache, somnolence	Streptococcus mitis, Streptococcus viridans, Haemophilus parainfluenzae.	Ampicillin/ sulbactam	Medial eyebrow approach with concurrent frontal sinus trephination.	well	[29]
30	17	M	Headaches, rhinorrhea, and emesis.	Streptococcus intermedius.	Ceftriaxone, metronidazole.	Medial eyebrow approach with concurrent frontal sinus trephination.	Well	[29]
31	12	F	Headache, fever, cough	Streptococcus intermedius.	Vancomycin, meropenem, ceftriaxone, metronidazole.	Endoscopic maxillary antrostomy, ethmoidectomies, frontal sinus exploration, and sphenoid sinusotomies.	Well	[30]

the diagnostic accuracy of imaging and clinical presentation in patients with intracranial complications and found that MRI was the most accurate in establishing the diagnosis (97%), while CT and clinical presentation were 87% and 82% accurate, respectively.[33]

Treatment of epidural abscesses usually requires a combination of antibiotics, surgical intervention and eradication of the primary infected site.[19] Surgical treatment requires removal of nasal and intracranial abscesses so that microbiological culture specimens can be obtained as a means of improving antibiotic efficacy. However, the need for surgery in some patients with epidural abscesses has been questioned. Some scholars believe that surgical treatment may not be necessary in patients with (1) no neurological deficit; (2) no occupying effect on CT scan; and (3) effective antibiotics. Some scholars believe that antibiotics alone can be used in patients with MRI-detected lesions that are too small for surgical drainage. However, most scholars believe that antibiotic therapy alone cannot halt the progression of the infection, which makes it nearly impossible to eradicate the infection.[34,35] Regarding surgical options, craniotomy or puncture and drainage can be employed to eliminate epidural abscesses, while sinus surgery serves as a complementary procedure to eliminate nasal pus,[36] According to the literature, endoscopic sinus surgery (ESS) is now the standard procedure for the treatment of complex cases of frontal sinusitis.[1] For antibiotic use, intravenous broad-spectrum antibiotic therapy should be continued for 2–4 weeks, followed by oral or intravenous supplementation for up to 8 weeks, depending on the patient's response to treatment.[6] In the presence of osteomyelitis, it is recommended that antibiotic therapy be extended for an additional 8 weeks or more.[37] Premature discontinuation of broad-spectrum antibiotics during treatment may lead to inadequate infection control.[35] We gave the patient in this case an endoscopic

whole group sinus opening under general anaesthesia with adequate exposure of the frontal sinus openings and sinus cavities, removal of pus and postoperative sending for culture. For better control of infection and prevention of recurrence, patients were given vancomycin combined with meropenem for anti-infective treatment after surgery. Long-term sinusitis treatment plays a very important role in order to achieve better therapeutic results.

Conclusion

Epidural abscess is a rare complication of sinusitis, and its treatment process is long and difficult. Misdiagnosis and missed diagnosis can lead to severe consequences and endanger the patient's life. Therefore, early diagnosis, timely anti-infection treatment, and surgical intervention are crucial for preventing focal deficits and complications in these patients. We hope that this case will help neurologists expand their clinical thinking, enrich their treatment experience, and reduce misdiagnosis and missed diagnosis.

Ethical Statement

The research does not require the approval of the ethics committee.

Consent to Publish

Written informed consent was obtained from the minor(s)' legal guardian/next of kin for the publication without any potentially identifiable images or data included in this article.

Author Contributions

All authors made substantial contributions to the development and execution of the study, including the design, data acquisition, analysis, and interpretation. The authors participated in the drafting, revision, and critical review of the article and gave their final approval for publication. They are accountable for all aspects of the work and have agreed on the submission to the specified journal.

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Disclosure

All authors declare no conflict of interest.

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