

Complications of Acute Sinusitis: A Review and Case Series

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Abstract

Acute rhinosinusitis is a common infection, however a small proportion of cases can progress to serious complications with significant morbidity and mortality. Cerebral venous sinus thrombosis, subdural empyema, meningitis, cerebral abscess and cerebritis are some of the potential intracranial complications. Orbital complications include peri and orbital cellulitis, the latter requiring treatment with surgical drainage and intravenous antibiotics. We present a review and case series of patients with complications from acute sinusitis, correlate the imaging to their clinical presentations and briefly discuss their clinical management.

Introduction

Acute rhinosinusitis (ARS) is an inflammatory process of the nasal mucosa and paranasal sinuses, usually caused by viral infection and is usually self-resolving (Table1). The true incidence of acute virus rhinosinusitis has always been described as high [1], with an estimation that shows adults are likely to suffer two to five episodes of viral ARS per year, in comparison to seven to ten episodes per year in children [2]. Post-viral ARS occurs as a perpetuation of the inflammatory condition, even when the viral agent has been eliminated, with a reported estimate of 3.4 cases per 100/year [3]. It is also estimated that only 0.5–2% would progress to Acute Bacterial Rhinosinusitis (ABRS). The incidence of ABRS complications is approximately 3 per million of the population per year, despite vastly different utilization of antibiotics in various countries. This figure has not reduced significantly despite the advent of widespread antibiotic prescribing [4]. Delays in starting treatment, incomplete antibiotic regiment or immunosuppression are some of the risk factors leading to complications from acute rhinosinusitis [5]. Complications of ABRS include periorbital, intra-cranial and osseous conditions which are potentially life-threatening (Table2), where an early commencement of intravenous antibiotics and /or surgical drainage is carried out.

This is imperative to avoid long term sequelae. In all studies, orbital complications are the most frequent while osseous appear to be relatively uncommon, with males significantly more affected than females. Orbital complications appear more common in children while intracranial complications can occur at any age, with a preponderance of young adults [4,5]. Anatomy of paranasal sinus venous drainage and cerebral venous drainage up to 3% of patients with ARS present with orbital inflammation including preseptal cellulitis and orbital cellulitis, orbital abscess and subperiosteal empyema [5,6]. Orbital inflammatory complications are often caused by infection of ethmoid or frontal sinus due to their proximity to the orbits [7]. The ethmoid sinuses are drained by anterior and posterior valveless ethmoidal veins, and in conjunction with delicate lamina papyracea which offer the route of least resistance for infection to travel into the orbit [5]. The valveless ethmoidal veins drain into ophthalmic veins, thus increasing risk of cavernous venous sinus thrombosis from ethmoid sinusitis [5]. Approximately 3% of intracranial complications such as cerebritis, subdural empyema, meningitis, venous sinus thrombosis and cerebral abscess are due to sinusitis [8], commonly arising from frontal sinus, followed by sphenoid, ethmoid and maxillary sinuses.

Table 1: Clinical signs and symptoms of acute rhinosinusitis (1- 4 weeks duration).

Fever
Headache
Facial pain
Rhinitis
Nasal congestion, leading to altered or reduced olfaction
Post-nasal discharge, thick consistency

Table 2: Clinical signs of rhinosinusitis with orbital / intracranial involvement.

Swollen eyelids due to fluid retention and inflammation
Injected, painful red eye
Proptosis, difficulty in initiating eye movements
Visual blurring
Altered conscious level
Headache, nausea, neck stiffness, photophobia (meningism)

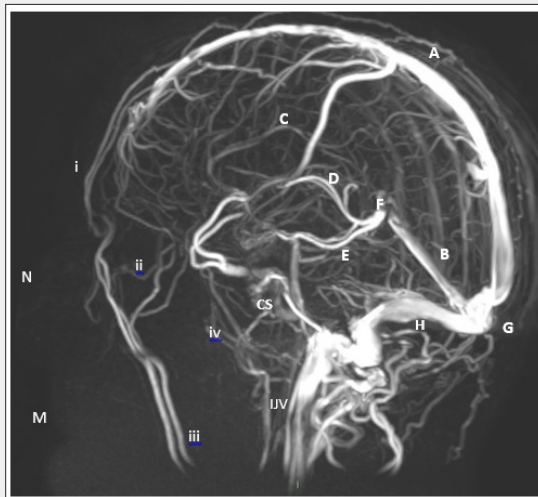


Figure 1: Anatomy of venous drainage of the paranasal sinus and cerebral venous system

- A: Superior sagittal sinus i: Frontal/supratrochlear vein
 B: Straight sinus ii: Superior ophthalmic vein
 C: Inferior sagittal sinus iii: Facial vein
 D: Internal cerebral vein iv: Pterygoid plexus
 E: Basal vein of Rosenthal
 F: Vein of Galen
 G: Torcula
 H: Transverse sinus
 CS: Cavernous sinus
 IJV: Internal jugular vein
 N: Nose
 M: Mouth

The abundant emissary valveless venous Behcet's plexus of the posterior frontal sinus mucosa communicates with diploic veins and dura [5] where infection can spread through intact sinus walls to intracranial dura, meninges and parenchyma. The emissary and diploic veins network from the frontal sinuses which communicate with valveless dural venous system and cavernous sinus allow propagation of infection and septic thrombi, hence cause cerebral venous sinus thrombosis. Anterior to frontal sinus, infection can spread through the bony wall or via diploic venous drainage causing thrombophlebitis with or without frank osteomyelitis to cause a subgaleal abscess, called Pott's puffy tumor which is rarely seen since the introduction of antibiotics [5,9]. The maxillary vein which drains both sphenoid and maxillary sinuses forms a network with pterygoid venous plexus (Figure 1) which communicates with the dural sinuses at the skull base, allowing spread of infection causing meningitis [10].

Surgical management and relevant anatomical landmarks

Table 3: Anatomical structures requiring documentation on CT sinus report [14].

Anatomical structure	Required documentation
Cribriform Plate	· Keros classification (type I – III)
	· Bone dehiscence of skull base
	· Height of fovea ethmoidalis
Lamina papyracea (LP)	· Orbital prolapse into ethmoid sinus
	· Dehiscent (LP)
	· Presence of Haller cells
Onodi Cells	· Uncinate process origin
	· Presence of Onodi cells
Sphenoid Sinus	· Dehiscence of optic nerve within Onodi cells
	· Pneumatization pattern
	· Dehiscence of carotid canal
Ethmoidal artery (anterior)	· Intersinus septation
	· Identify ethmoidal notch, bony canal dehiscence
	· Presence of supraorbital pneumatization

Methods of surgical intervention have evolved in the past two decades, to more minimally invasive functional endoscopic sinus surgeries, that could at times be combined with open approaches. Despite these less invasive approaches and advances in technology, they still carry risks for developing serious life-threatening complications. Surgical intervention is usually reserved for

complicated acute rhinosinusitis, which in turn has specific clinical and radiological findings. On initial surgical assessment, careful consideration is taken to highlight, if any symptoms or signs suggesting intra / extra cranial complications including orbital complications, followed by endoscopic examination when tolerated, which usually demonstrates evidence of pus and injected nasal mucosa. Computed Tomography (CT) scan of sinuses aids in confirming the diagnosis, delineates extent of complications, facilitates surgical planning and provides an opportunity to identify anatomical variations that predispose patients to surgical complications. A general principal is that when ARS complications require surgical treatment (e.g. intra-cranial abscess, orbital / subperiosteal abscess, Pott's puffy tumor), then concomitant surgical drainage of the affected sinuses is usually recommended [11]. The key critical areas the surgeon needs to be aware of on imaging are those that place patients at risk for surgical complications. A mnemonic based approach provides a simplistic means for recalling the critical variants to report and document on the pre-operative scans. The mnemonic 'CLOSE' (cribriform plate, lamina papyracea, Onodi cell, sphenoid sinus pneumatization, and (anterior) ethmoidal artery), has been popular amongst ENT surgeons (Table 3).

Acute sinusitis and imaging

The paranasal sinuses are best evaluated with fine-slice CT reconstructed using high-resolution bony algorithm of 1mm or less. Soft tissue windows should be included to evaluate paranasal sinus opacification, as the different densities demonstrated would give further information about its contents.

MRI scan of paranasal sinuses should be considered in cases of intracranial complications or when further evaluation is required for possible paranasal soft tissue mass or neoplasm. In acute emergencies where clinically a differential of acute orbital cellulitis or possible intracranial extension of disease secondary to acute sinusitis is raised, the radiologist responsible for overseeing

the protocol of the CT examination should always consider performing a contrast-enhanced scan at initial presentation, especially in the paediatric population. Post contrast scans are superior to non-contrast CT in delineating rim-enhancing collections, identifying presence of venous sinus thrombosis and demonstrating the extent of intracranial complications. Moreover, it would save patients from unnecessary radiation exposure from acquiring a repeat CT scan with contrast when performed from the outset. Dental sinusitis remains a common cause for maxillary sinusitis, therefore CT sinuses should always include the upper jaw teeth to allow for complete evaluation [12]. CT sinuses for patients with acute rhinosinusitis typically demonstrates sinus opacity and mucosal thickening (Figures 2, 3&4) [13]. Paranasal sinus air-fluid level is often demonstrated; however should be correlated clinically, as there are several causative differentials, depending on site (Table 4). In the presence of clinical acute rhinosinusitis however, air-fluid level in maxillary or frontal sinus usually indicates acute bacterial rhinosinusitis with obstruction of sinus drainage necessitating urgent surgical management to reduce risk of intracranial or orbital complications (5).

Table 4: Differentials for causes of air-fluid level in paranasal sinuses [5].

Prolonged nasogastric tube placement
Introduction of emergency nasal airway
Trauma, haemorrhage and epistaxis
Sphenoid sinus - skull base or temporal bone fracture with subsequent CSF rhinorrhoea
Ethmoid sinus - unusual, due to poor sinus drainage or infrequently, a ruptured mucocoele
Frontal sinus - CSF rhinorrhoea secondary to an encephalocele.

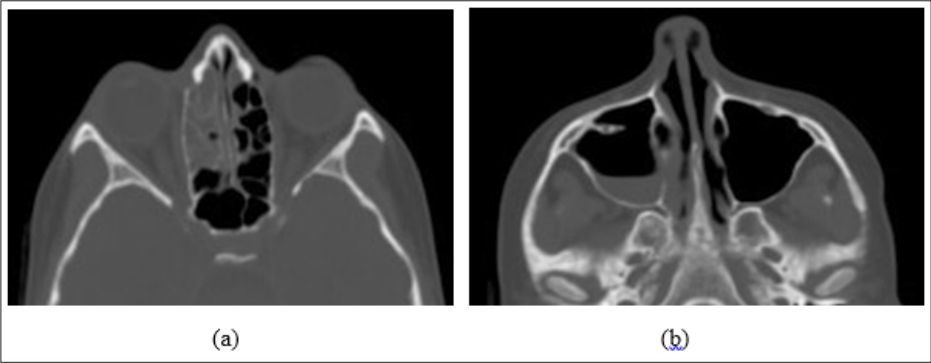


Figure 2: CT sinuses findings of acute sinusitis.
(a) Bony windows non-contrast CT axial images of paranasal sinus showing right ethmoid sinus opacification.
(b) Right maxillary sinus air-fluid level consistent with acute bacterial sinusitis.



Figure 3: Soft tissue window axial image non-contrast CT sinus showing bilateral maxillary sinus air-fluid levels with non-dependent air bubbles consistent with acute sinusitis.

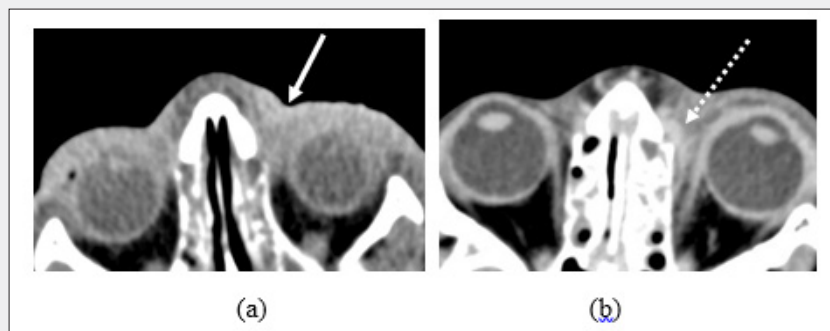


Figure 4: Non-contrast versus post-contrast axial CT sinus for acute sinusitis and orbital swelling (obtained at different levels). Subperiosteal empyema (dashed arrow) on post contrast scan (b) was overlooked as medial canthal soft tissue thickening (solid arrow) on the non-contrast scan.

Clinical Examples

Venous sinus thrombosis, pachymeningitis and subdural empyema

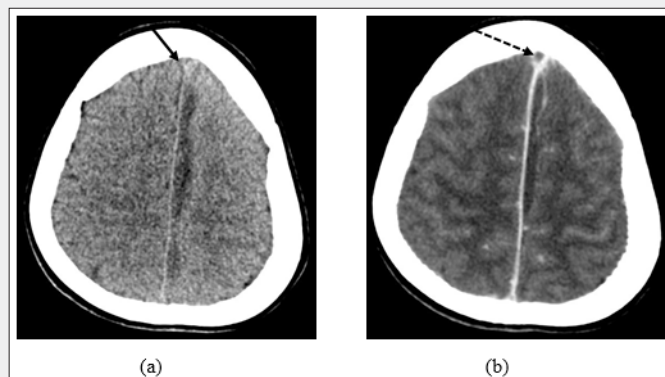


Figure 5(a) & (b): Pre and post-contrast CT brain. Post-contrast CT scan demonstrates rim enhancing left parasagittal subdural empyema and filling defect (dashed arrow) within the anterior superior sagittal sinus in keeping with venous sinus thrombosis, which could have been easily missed on the non-contrast scan alone (solid arrow) seen as high density within the sinus.

An 11-year-old boy presented with swollen red painless right eye associated with drowsiness, neck stiffness, photophobia and left lower limb weakness. An emergency CT brain showed superior sagittal sinus thrombosis and subdural empyema, (Figure 5) with complete opacification of his left frontal, ethmoid and maxillary sinuses. He underwent bilateral functional endoscopic sinus surgery (FESS) and was treated with intravenous antibiotics and unfractionated heparin. However, the headache persisted

with minimal recovery of his left leg weakness. Post contrast CT head performed showed unresolved subdural empyema (Figure 6), which was then evacuated. Despite this, subsequent Magnetic Resonance Imaging (MRI) brain showed further enlargement of posterior parafalcine subdural empyema (Figure 7). This led to 2 STEALTH-guided Burr holes surgeries to drain it with subsequent complete recovery.

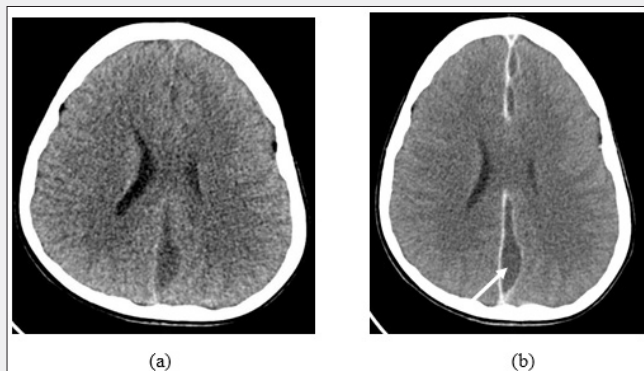


Figure 6(a) & (b): Pre and post contrast CT brain at level of corona radiata illustrates the importance of performing a post contrast scan as it demonstrates the extent of subdural empyema distinctly compared to non-contrast CT alone. Note the thickened enhancing midline falx (arrow) and dura, in keeping with pachymeningitis, which accounted for the patient's symptoms of meningism.

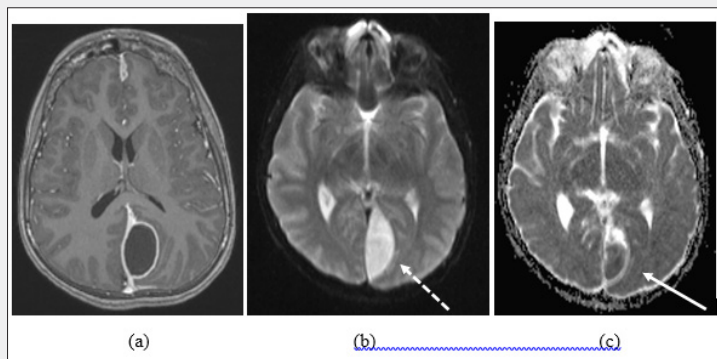


Figure 7: MRI brain with contrast. Despite bilateral FESS and craniotomy for evacuation of the anterior left parafalcine subdural empyema, the patient had persistent leg weakness prompting a repeat MRI brain (a) Post-contrast T1 axial showing increased size of rim enhancing posterior parafalcine subdural empyema. (b) B1000 image showing high signal within the empyema (dashed arrow). (c) ADC map image showing corresponding low signal within empyema (solid arrow) indicating restricted diffusion, in keeping with purulent abscess..

Subdural empyema, cerebritis and cerebral abscess

A 15-year-old girl presented with fever, lower limb weakness, a right retro-orbital headache, rhinitis, photophobia and left homonymous hemianopia. A non-contrast CT brain showed opacification of right frontal sinus with bilateral maxillary sinus

air-fluid levels and a shallow right parafalcine subdural empyema (Figure 8). An MRI head was also performed (Figures 8, 9, 10) to identify cause of her visual disturbance and limb weakness (Figure 11). She underwent surgical drainage of right frontal sinus. The subdural empyema was managed with intravenous antibiotics [14].

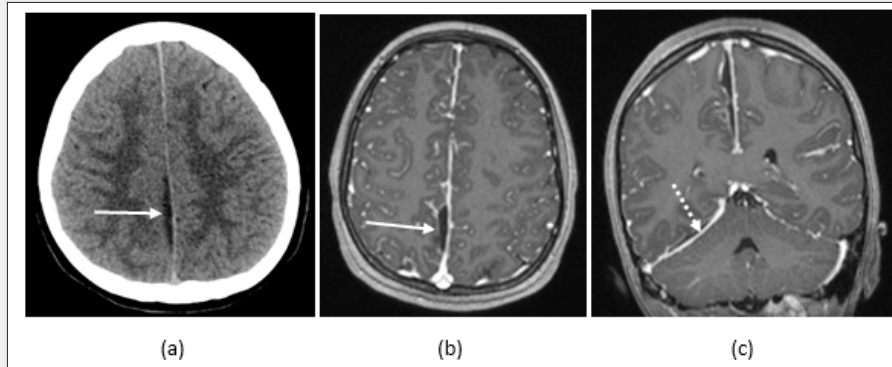


Figure 8(a): Non-contrast axial CT brain showing a right posterior parafalcine subdural empyema (solid arrow), better delineated by MRI post-contrast T1 axial (b) and coronal (c) sequences also showing a shallow right tentorial leaf subdural abscess (dashed arrow)..

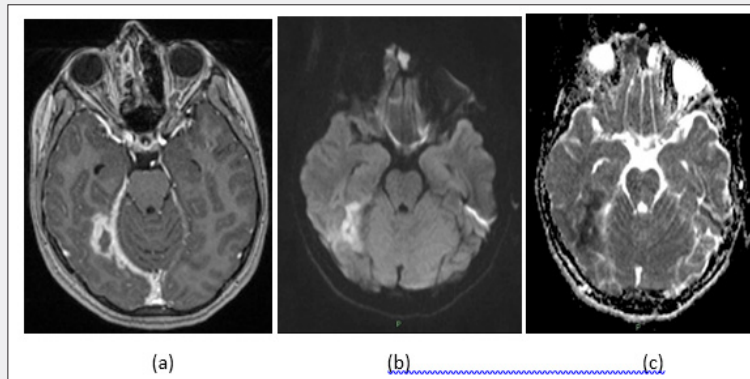


Figure 9: MRI brain (a) Post-contrast T1 axial scan (b) B1000 (c) ADC map showing focal rim enhancing intracerebral abscess with restricted diffusion at right temporo-occipital region. This was associated with adjacent oedema and cerebritis.

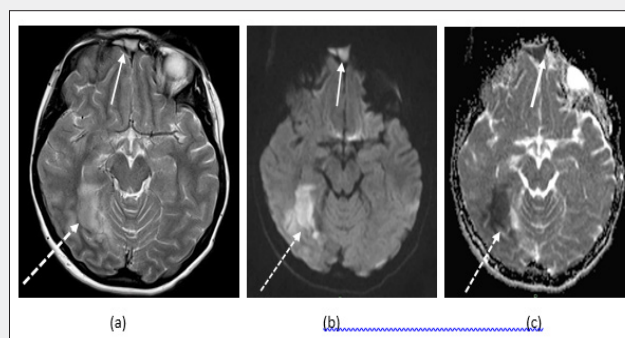


Figure 10: MRI brain (a) T2 axial sequence showing parenchymal high T2 signal (dashed arrows) indicating oedema of the right medial temporo-occipital lobe (b) B1000 also showing focus of high signal (c) ADC map with corresponding low signal of the same area in keeping with restricted diffusion from acute infarct or cerebritis. This would account for the patient's left homonymous hemianopia. Frontal bacterial sinusitis with restricted diffusion (solid arrows).

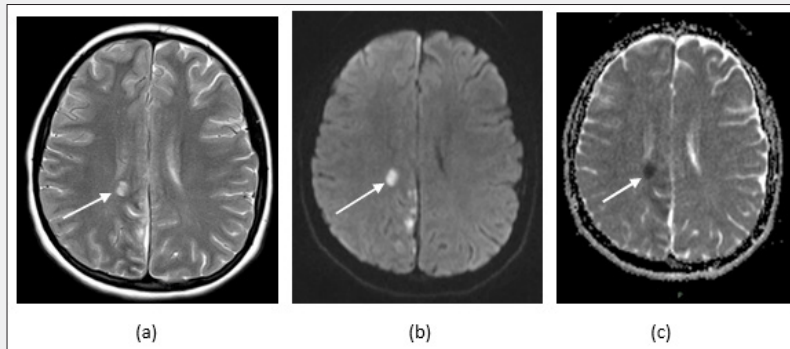


Figure 11: MRI brain (a) T2 axial sequence (b) B1000 and (c) ADC map showing right parasagittal posterior fronto-parietal region cortical cerebritis and focal intracerebral abscess (arrow) which accounted for the patient's left leg weakness.

Presumed traumatic subdural haematoma

A 20-year-old male presented to Accident and Emergency when found collapsed with a GCS score of 4 and unequal pupil sizes. An urgent CT brain was performed (Figure 12) showed a

moderate sized subdural fluid causing significant mass effect. The neurosurgeons performed emergency craniotomy for evacuation, which revealed not a subdural haematoma as thought initially but a large subdural empyema.

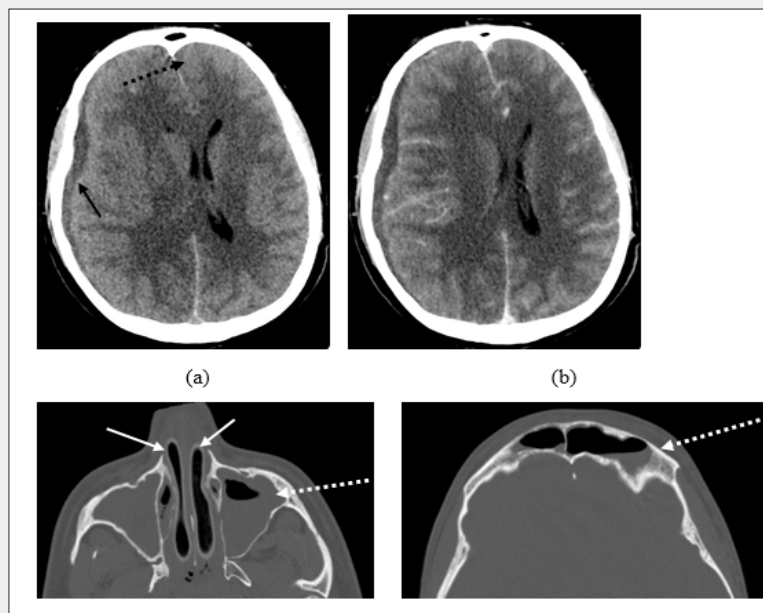


Figure 12: Axial non-contrast CT head (a) Right convexity subdural hypoattenuation fluid (solid black arrow), midline shift (dashed black arrow) and contralateral ballooning of left lateral ventricle in keeping with raised intracranial pressure. (b) Post-contrast CT head axial image did not show any subdural rim enhancement. (c) (d) Bilateral nasopharyngeal airway adjuncts in situ (solid white arrows) which were thought initially accounted for paranasal sinus opacification and air-fluid levels (dashed white arrows), however in retrospect were in keeping with acute infective sinusitis. The patient had chronic sinusitis which was demonstrated on a previous CT sinus scan performed 18 months earlier.

On retrospective review, the hypoattenuating subdural fluid on CT brain was initially reported as hyperacute right subdural haematoma secondary to presumed trauma, as there was no rim-enhancement on post-contrast CT brain. There were left maxillary and frontal sinuses opacification with air-fluid levels which were overlooked. An endoscopic sinus surgery was carried out to drain the sinuses.

Frontal subcutaneous oedema and abscess - Potts Puffy tumor

A 30-year-old male presented with intermittent vomiting, fever, frontal headache and slowly progressive, tender swelling over the forehead. Post contrast CT brain (Figure 13) was performed showed a frontal extradural/subgaleal abscess associated with left frontal sinusitis and dehiscence of the anterior and posterior frontal sinus walls (Figure14), in keeping with Pott's puffy tumor. The patient underwent trans-cranial

needle aspiration of the extradural abscess, left external frontal trephination via a Lynch Howarth incision and left endoscopic sinus surgery. Intra-operative findings included severely inflamed nasal mucosa with frank pus in the left maxillary, ethmoidal and frontal sinuses which were washed out and a corrugated drain was placed.

Orbital cellulitis with intra-orbital abscess and subperiosteal empyema

A 10-year-old boy presented with progressive right eye swelling, proptosis, reduced eye movement and difficulty eye opening. CT sinuses performed revealed right-sided orbital cellulitis with intra-orbital abscess (Figure 15), and opacification of the paranasal sinuses. He was commenced on intravenous antibiotics. The paranasal sinuses and orbital abscess were drained with complete recovery.

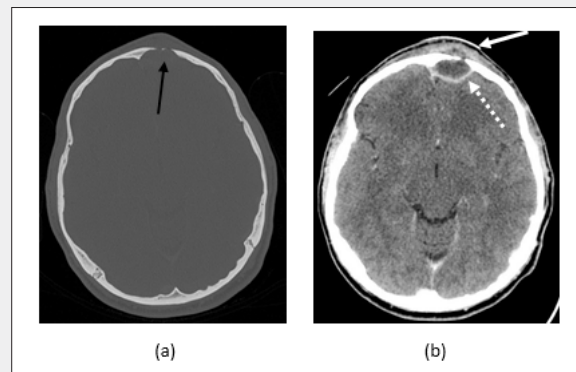


Figure 13: (a) Bony reconstruction of axial post-contrast CT sinus showing frontal bony destruction (black arrow). (b) Soft tissue windows of the same scan showing left frontal subcutaneous soft tissue swelling and subgaleal abscess (solid white arrow). There was a further rim enhancing left frontal cerebral abscess (dashed white arrow).

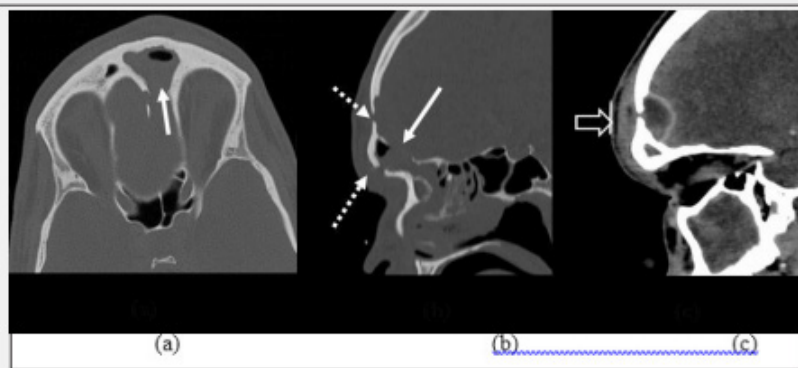


Figure 14: (a) Bony reconstruction of axial post-contrast CT sinus of the same patient showing air-fluid level within opacified left frontal sinus with erosion of posterior frontal sinus wall (solid arrow). (b) Sagittal view showing bony erosions of anterior (dashed arrows) and posterior frontal sinus walls. (c) Soft tissue windows of the sagittal view showing rim-enhancing subcutaneous abscess, Potts puffy tumor (block arrow) and cerebral abscess.



Figure 15: Post-contrast CT sinus coronal (a) axial (b) (c) slices showing bilateral frontal, ethmoid and right maxillary sinus opacification due to sinusitis, right proptosis, right subperiosteal abscess (solid white arrow) and superior orbital abscess (dashed black arrow).

Conclusion

Most episodes of acute rhinosinusitis run a definite and limited course, usually with complete resolution. However, a small percentage can result in serious orbital or intracranial complications which require urgent surgical management. Post-contrast CT head with fine bony reconstructions should be considered as first-line imaging in these circumstances, as certain crucial findings can be missed on non-contrast scans alone. MRI is usually required for orbital or intracranial complications. Good communication between medical, surgical and radiology teams is essential to pinpoint the correct diagnoses and facilitate timely planning of surgical interventions to achieve the best outcomes.

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