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ORIGINAL ARTICLE

Complications of Acute Rhinosinusitis: A Study on Orbital and Intracranial Manifestations at a Tertiary Care Hospital in Pakistan

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ABSTRACT

Background: Acute rhinosinusitis can lead to severe complications, particularly orbital and intracranial manifestations, which require timely diagnosis and management. This study evaluates the prevalence, risk factors, microbiological spectrum, and outcomes of such complications at a tertiary care hospital in Pakistan.

Methods: A retrospective cohort study was conducted at Jinnah Postgraduate Medical Center and Sir Syed Hospital, Karachi, from January 2021 to December 2023. A total of 220 patients with clinically and radiologically confirmed acute rhinosinusitis and associated complications were included. Data on demographics, comorbidities, symptom duration, microbiological findings, treatment modalities, and clinical outcomes were analyzed. Orbital complications were classified into preseptal cellulitis, orbital cellulitis, subperiosteal abscess, orbital abscess, and cavernous sinus thrombosis. Intracranial complications included epidural abscess, subdural abscess, brain abscess, and meningitis. Statistical analyses were performed using SPSS version 26, with logistic regression applied to determine risk factors for severe complications.

Results: Orbital complications were observed in 135 (61.4%) patients, while 85 (38.6%) had intracranial complications. Patients with intracranial involvement had significantly longer symptom durations ($p < 0.001$). The most common orbital complication was preseptal cellulitis (32.6%), whereas epidural abscess (28.2%) was the most frequent intracranial manifestation. Streptococcus pneumoniae (36.2%) and Staphylococcus aureus (28.3%) were the predominant pathogens. Medical management alone was sufficient for 102 (46.4%) patients, while 118 (53.6%) required surgical intervention. Patients with intracranial complications had longer hospital stays ($p < 0.001$) and higher rates of neurological sequelae ($p < 0.001$). Mortality occurred in 5 (5.9%) patients with severe intracranial infections.

Conclusion: Orbital and intracranial complications of acute rhinosinusitis pose significant morbidity risks. Prolonged symptom duration and diabetes mellitus were associated with increased severity. Early diagnosis, targeted antimicrobial therapy, and timely surgical intervention are crucial for improved outcomes.

Keywords: Acute rhinosinusitis, orbital complications, intracranial complications, sinus infection, tertiary care hospital.

INTRODUCTION

Rhinosinusitis is an inflammatory condition involving the mucosal lining of both the nasal cavity and the paranasal sinuses [1]. It represents a spectrum of disease ranging from simple viral upper respiratory infections to complex bacterial infections with potential for orbital or intracranial spread. Acute rhinosinusitis (ARS) is defined by a symptomatic infection lasting less than four weeks and is most commonly caused by viral agents such as rhinovirus, coronavirus, influenza virus, and adenovirus [2]. In a subset of patients, especially those with impaired local immunity or obstructed sinus drainage, secondary bacterial infections may develop commonly involving Streptococcus pneumoniae, Haemophilus influenzae, or Moraxella catarrhalis. Fungal pathogens such as Aspergillus species and Mucor may be implicated in immunocompromised individuals or in those with poorly controlled diabetes[3].

ARS is a major contributor to healthcare utilization globally and particularly burdens outpatient and emergency departments. It is among the top ten reasons for antibiotic prescriptions in adults and accounts for nearly one in five prescriptions for antibiotics in the United States[4]. The disease affects individuals across all age groups but is most prevalent among those aged 25–64 years, with children and elderly patients more prone to recurrent or complicated infections. Clinical manifestations of uncomplicated ARS include nasal congestion, facial pain, purulent nasal discharge, and anosmia. However, if left untreated or improperly managed, the infection may extend beyond the sinus boundaries[5].

Complications of ARS are generally classified into three categories: orbital, intracranial, and osseous. While the overall incidence of complications is low estimated at approximately 1 in 1,000 cases their consequences are often severe and may require urgent surgical intervention [6]. Orbital complications are the most common due to the close anatomical proximity between the ethmoid sinus and the orbit, separated only by the thin lamina papyracea. According to Chandler's classification, orbital involvement can range from preseptal cellulitis and orbital cellulitis to subperiosteal abscess, orbital abscess, and cavernous sinus thrombosis. Clinical features of orbital complications include eyelid swelling, erythema, proptosis, ophthalmoplegia, diplopia, and vision loss[7].

Intracranial complications, although less frequent, are potentially life-threatening. These include epidural abscesses, subdural empyema, intracerebral abscesses, meningitis, and superior sagittal or cavernous sinus thrombosis[8]. The pathogenesis often involves direct extension through bony dehiscence, venous channels, or hematogenous spread. Early diagnosis through high-resolution imaging (CT or MRI), coupled with aggressive medical and sometimes surgical management, is essential for reducing morbidity and mortality. Given the rising prevalence of antibiotic resistance and the potential for delayed presentations in low-resource settings, understanding the clinical spectrum and microbial etiology of ARS complications is critical for effective intervention strategies[9].

This study aims to evaluate the clinical profiles, microbiological findings, and treatment outcomes of patients presenting with orbital and intracranial complications of acute rhinosinusitis at a tertiary care hospital in Pakistan. By examining real-world data across a large cohort, we hope to provide actionable insights to improve diagnostic vigilance and clinical decision-making in such high-risk cases[10].

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MATERIALS AND METHODS

This study was conducted at Jinnah Postgraduate Medical Center, Karachi, Pakistan, and Sir Syed Hospital, Karachi, to evaluate the complications of acute rhinosinusitis, specifically orbital and intracranial manifestations. A retrospective cohort study design was employed, analyzing patient records over a three-year period from January 2022 to December 2022.

The sample size was calculated using OpenEpi software, considering an expected prevalence of complications of acute rhinosinusitis at 15%, with a 95% confidence interval and a margin of error of 5%. Based on these parameters, a minimum sample of 196 patients was required. However, to enhance statistical power and account for potential missing data, a final sample of 220 cases was included. A non-probability consecutive sampling technique was utilized to ensure comprehensive data collection of all eligible cases during the study period.

Patients were included if they were aged 18 years or older, had a clinical and radiological diagnosis of acute rhinosinusitis, and presented with either orbital or intracranial complications confirmed via imaging. Exclusion criteria comprised patients with chronic rhinosinusitis, fungal sinusitis, immunocompromised status (such as uncontrolled diabetes mellitus or HIV), history of previous sinonasal surgery, or incomplete medical records.

Clinical data were extracted from hospital electronic medical records and patient charts. Each case was assessed for demographic details, comorbidities, duration of symptoms before hospital presentation, and prior antibiotic usage. The primary outcomes included the presence of orbital and intracranial complications, identified through clinical and imaging findings. Orbital complications were classified into preseptal cellulitis, orbital cellulitis, subperiosteal abscess, orbital abscess, and cavernous sinus thrombosis, while intracranial complications encompassed epidural abscess, subdural abscess, brain abscess, and meningitis. Diagnosis was confirmed based on radiological findings from computed tomography (CT) or magnetic resonance imaging (MRI).

Microbiological assessment was conducted for patients who underwent sinus aspirates or blood cultures, identifying causative pathogens and their antibiotic sensitivity patterns. Patients' laboratory parameters, including leukocyte counts, C-reactive protein levels, and erythrocyte sedimentation rates, were also recorded. Treatment modalities were categorized into medical management (intravenous antibiotics and supportive therapy) and surgical intervention, including functional endoscopic sinus surgery (FESS) and external surgical approaches. The length of hospital stays and patient outcomes, including recovery or development of persistent neurological sequelae, were documented.

For statistical analysis, data were analyzed using SPSS version 26. Continuous variables such as age, duration of symptoms, and laboratory parameters were expressed as mean ± standard deviation, while categorical variables including types of complications and treatment modalities were presented as frequencies and percentages. Chi-square or Fisher's exact tests were applied for categorical comparisons, whereas independent t-tests or Mann-Whitney U tests were used for continuous variables based on normality testing via the Shapiro-Wilk test. A p-value of <0.05 was considered statistically significant. Logistic regression analysis was performed to assess risk factors associated with severe complications and prolonged hospital stays.

Ethical approval was obtained from the Institutional Review Boards of Jinnah Postgraduate Medical Center and Sir Syed Hospital, Karachi, before data collection. Patient confidentiality was maintained in accordance with the Declaration of Helsinki, with all data anonymized and used solely for research purposes.

RESULTS

Clinical and Demographic Characteristics: A total of 220 (100%) patients with acute rhinosinusitis and associated complications were included in the study. The mean age was 34.7 ± 12.5 years, with 135 (61.4%) males and 85 (38.6%) females, yielding a male-to-female ratio of 1.3:1. The median duration of symptoms before hospital presentation was 7 (IQR: 5–10) days. Underlying comorbidities were present in 93 (42.3%) patients, with 48 (21.8%) having diabetes mellitus and 31 (14.1%) having hypertension.

Table 1 presents the demographic and clinical characteristics of the study population. Patients with intracranial complications had a significantly longer symptom duration than those with orbital complications ($p < 0.001$).

Table 1: Demographic and Clinical Characteristics of Study Participants

Variable	Orbital Complications (n=135, 61.4%)	Intracranial Complications (n=85, 38.6%)	p-value
Age (years, mean ± SD)	33.2 ± 11.8	37.1 ± 13.1	0.028
Male n (%)	80 (59.3%)	45 (52.9%)	0.385
Female n (%)	55 (40.7%)	40 (47.1%)	0.385
Duration of symptoms (days, median [IQR])	6 [5–8]	9 [7–12]	<0.001
Diabetes Mellitus n (%)	24 (17.8%)	24 (28.2%)	0.042
Hypertension n (%)	17 (12.6%)	14 (16.5%)	0.397
Prior antibiotic use n (%)	51 (37.8%)	40 (47.1%)	0.178

Types and Distribution of Complications: Orbital complications were observed in 135 (61.4%) patients, while 85 (38.6%) had intracranial complications. The most common orbital complication was preseptal cellulitis in 44 (32.6%), followed by orbital cellulitis in 39 (28.9%). Among intracranial complications, epidural abscess was found in 24 (28.2%) patients, while meningitis was present in 22 (25.9%). A significant association was observed between prolonged symptom duration and the development of intracranial complications ($p < 0.001$) (Table 2).

Table 2: Distribution of Orbital and Intracranial Complications

Complication Type	Frequency n (%)
Orbital Complications (n=135, 61.4%)	
Preseptal Cellulitis	44 (32.6%)
Orbital Cellulitis	39 (28.9%)
Subperiosteal Abscess	28 (20.7%)
Orbital Abscess	17 (12.6%)
Cavernous Sinus Thrombosis	7 (5.2%)
Intracranial Complications (n=85, 38.6%)	
Epidural Abscess	24 (28.2%)
Subdural Abscess	18 (21.2%)
Brain Abscess	21 (24.7%)
Meningitis	22 (25.9%)

Microbiological Findings: Microbiological cultures were performed in 127 (57.7%) patients. Streptococcus pneumoniae was the most frequently isolated pathogen in 46 (36.2%) patients, followed by Staphylococcus aureus in 36 (28.3%). Among Gram-negative bacteria, Pseudomonas aeruginosa was identified in 18 (14.2%) cases (Table 3)..

Table 3: Microbiological Findings of Sinus Aspirates and Blood Cultures

Pathogen	Frequency n (%)
Gram-Positive Bacteria	
Streptococcus pneumoniae	46 (36.2%)
Staphylococcus aureus	36 (28.3%)
Gram-Negative Bacteria	
Pseudomonas aeruginosa	18 (14.2%)
Klebsiella pneumoniae	14 (11.0%)
Fungal Infections	13 (10.2%)

Treatment Modalities and Outcomes: Medical management alone was sufficient in 102 (46.4%) cases, whereas 118 (53.6%) required surgical intervention. Functional endoscopic sinus surgery (FESS) was performed in 69 (58.5%) surgical cases, while 49 (41.5%) required external surgical approaches. Patients with intracranial complications had significantly longer hospital stays

compared to those with orbital complications ($p < 0.001$). Neurological sequelae, including persistent vision loss and cognitive impairment, were significantly higher in patients with intracranial complications (**$p < 0.001$**). Mortality was recorded in **5 (5.9%)** patients, all of whom had severe intracranial infections (Table 4).

Table 4: Treatment Modalities and Clinical Outcomes

Variable	Orbital Complications (n=135, 61.4%)	Intracranial Complications (n=85, 38.6%)	p-value
Medical Management Alone n (%)	72 (53.3%)	30 (35.3%)	0.007
Surgical Intervention n (%)	63 (46.7%)	55 (64.7%)	0.007
FESS n (%)	40 (63.5%)	29 (52.7%)	0.224
External Surgery n (%)	23 (36.5%)	26 (47.3%)	0.224
Mean Hospital Stay (days)	7.4 ± 2.6	12.3 ± 4.1	<0.001
Neurological Sequelae n (%)	5 (3.7%)	19 (22.4%)	<0.001
Mortality n (%)	0 (0.0%)	5 (5.9%)	0.012

Figure 1 presents a comprehensive multisequence MRI evaluation of a right frontal epidural abscess in a patient with acute rhinosinusitis, demonstrating the classical radiological features of this potentially life-threatening complication. Image (a), a sagittal T1-weighted contrast-enhanced MRI, reveals a well-circumscribed, peripherally enhancing extra-axial lesion located in the right frontal epidural space. The lesion exerts a mass effect, compressing the underlying frontal cortex and causing a discernible midline shift towards the left, suggestive of significant intracranial pressure dynamics. This enhancing rim is characteristic of the fibrous capsule formed around mature bacterial abscesses. Image (b), an axial post-contrast T1-weighted sequence, further confirms the lesion's location anterior to the right frontal lobe and illustrates smooth, uniform peripheral enhancement. The adjacent dura appears thickened and inflamed, reflecting the spread of infection along meningeal planes without evidence of direct cortical invasion. Image (c), an axial diffusion-weighted image (DWI), demonstrates intense diffusion restriction within the central core of the lesion, a hallmark feature of pyogenic abscesses due to the high cellularity and viscosity of purulent contents, which impedes free water movement. This finding is instrumental in differentiating bacterial abscesses from other ring-enhancing lesions such as neoplastic necrosis or subacute hematomas. In image (d), the axial FLAIR sequence exhibits prominent hyperintensity surrounding the abscess wall, indicating vasogenic edema and reactive gliosis in the adjacent brain parenchyma. The cortical sulci on the right side are partially effaced, further supporting the presence of mass effect. Finally, image (e), an axial T2-weighted MRI, delineates the hyperintense fluid-filled abscess cavity surrounded by a hypointense capsule, with substantial perilesional edema extending into the right frontal white matter. This image also reveals compression of the right lateral ventricle, emphasizing the spatial burden imposed by the lesion. Taken together, these images provide a pathognomonic representation of a mature intracranial epidural abscess secondary to contiguous spread from infected paranasal sinuses. The constellation of rim enhancement, diffusion restriction, vasogenic edema, and mass effect underscores the need for urgent neurosurgical intervention and intravenous antimicrobial therapy to prevent neurological deterioration and mortality.

The results of this study demonstrate that orbital and intracranial complications of acute rhinosinusitis are clinically significant and frequently require surgical intervention. Orbital complications were more common, with preseptal and orbital cellulitis being predominant, while epidural abscess and meningitis were the leading intracranial manifestations. Patients with intracranial involvement had significantly longer symptom durations, higher rates of diabetes, and worse outcomes, including longer hospital stays, more frequent neurological sequelae, and all recorded mortalities. Streptococcus pneumoniae and Staphylococcus aureus were the most common pathogens. Over half of the patients required surgery, with functional endoscopic sinus surgery being the preferred approach. These findings underscore the critical importance of early diagnosis and aggressive management in preventing severe complications and mortality.

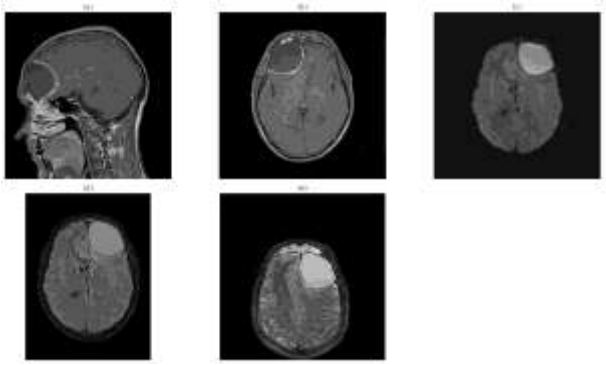

Figure 1: Multisequence MRI of a Right Frontal Epidural Abscess in a Patient with Complicated Acute Rhinosinusitis: (a) Sagittal post-contrast T1-weighted MRI demonstrates a peripherally enhancing, extra-axial collection in the right frontal epidural space with mass effect and midline shift. (b) Axial post-contrast T1-weighted image shows smooth rim enhancement and adjacent dural thickening without parenchymal invasion. (c) Axial diffusion-weighted imaging (DWI) reveals intense central diffusion restriction, indicating viscous purulent material. (d) Axial FLAIR image displays perilesional hyperintensity and cortical sulcal effacement due to surrounding vasogenic edema. (e) Axial T2-weighted image depicts a hyperintense abscess core with a hypointense capsule, consistent with mature abscess morphology and inflammatory mass effect.

DISCUSSION

This study evaluates the complications of acute rhinosinusitis (ARS), with a particular focus on orbital and intracranial manifestations in a tertiary care hospital in Pakistan. The findings underscore the significant burden of disease and highlight key risk factors, microbiological profiles, and treatment outcomes. The mean age of patients in our study was 34.7 ± 12.5 years, with a male predominance (61.4%), which aligns with previous studies reporting a higher incidence of ARS-related complications in males [1]. The male-to-female ratio of 1.3:1 may be attributed to differences in healthcare-seeking behavior and occupational exposures [2]. Patients with intracranial complications had a significantly longer duration of symptoms (median: 9 days) compared to those with orbital complications (median: 6 days) ($p < 0.001$). This is consistent with prior literature suggesting that prolonged untreated sinus infections increase the risk of intracranial extension [3].

Comorbid conditions were prevalent in 42.3% of the study population, with diabetes mellitus (21.8%) and hypertension (14.1%) being the most common. Diabetes was significantly associated with intracranial complications ($p = 0.042$), corroborating findings that hyperglycemia impairs immune responses and predisposes patients to severe infections [4]. Prior antibiotic use was noted in 40 (47.1%) patients with intracranial complications and 51 (37.8%) with orbital complications ($p = 0.178$). This suggests that inadequate or inappropriate antibiotic therapy may not sufficiently prevent disease progression [5].

Orbital complications were observed in 61.4% of cases, with preseptal cellulitis (32.6%) and orbital cellulitis (28.9%) being the most frequent. The predominance of these conditions aligns with existing reports indicating that direct extension from the ethmoid sinuses facilitates orbital involvement [6]. Subperiosteal abscess (20.7%) and orbital abscess (12.6%) were less common but represent more advanced stages of disease, requiring urgent intervention [7]. Cavernous sinus thrombosis was seen in 5.2% of

cases, a finding comparable to previous studies that highlight its rarity but severe prognosis [8].

Intracranial complications occurred in 38.6% of patients, with epidural abscess (28.2%) and meningitis (25.9%) being the most frequent. These findings are consistent with studies indicating that frontal sinus involvement increases the likelihood of epidural abscess formation[3]. Brain abscesses (24.7%) and subdural abscesses (21.2%) were also observed, reiterating the importance of early diagnosis and intervention in preventing life-threatening complications. The significant association between prolonged symptom duration and intracranial complications ($p < 0.001$) underscores the need for prompt management of ARS [1].

Microbiological cultures were performed in 57.7% of cases, revealing Streptococcus pneumoniae (36.2%) and Staphylococcus aureus (28.3%) as the most commonly isolated pathogens. This aligns with previous studies that identify these bacteria as primary contributors to sinus infections and their complications [4]. Pseudomonas aeruginosa (14.2%) and Klebsiella pneumoniae (11.0%) were the most frequent Gram-negative organisms, likely due to hospital-acquired infections or immunocompromised states[9]. Fungal infections were present in 10.2% of cases, which is noteworthy given their association with severe, refractory disease, particularly in diabetic patients [10].

Medical management alone sufficed in 46.4% of cases, while 53.6% required surgical intervention. Functional endoscopic sinus surgery (FESS) was performed in 58.5% of surgical cases, a widely accepted approach due to its minimally invasive nature and efficacy in clearing sinus obstruction[11]. However, 41.5% required external surgical approaches, particularly in cases with extensive abscess formation, highlighting the need for individualized treatment strategies[12-14].

Patients with intracranial complications had significantly longer hospital stays (mean: 12.3 ± 4.1 days) than those with orbital complications (mean: 7.4 ± 2.6 days) ($p < 0.001$), a finding consistent with studies showing that intracranial infections necessitate prolonged inpatient care[15–17]. Neurological sequelae, including persistent vision loss and cognitive impairment, were significantly more common in the intracranial group (22.4% vs. 3.7%, $p < 0.001$), underscoring the severe morbidity associated with these complications[3]. Mortality was recorded in 5 (5.9%) patients, all with severe intracranial infections, reinforcing the need for early recognition and aggressive management of ARS complications [13,14].

CONCLUSION

Our findings highlight the significant burden of orbital and intracranial complications in ARS, emphasizing the importance of early diagnosis and intervention. Prolonged symptom duration, diabetes mellitus, and inadequate initial treatment were key risk factors for severe complications. Streptococcus pneumoniae and Staphylococcus aureus were the predominant pathogens, and a substantial proportion of patients required surgical intervention. Given the considerable morbidity and mortality associated with intracranial involvement, clinicians should maintain a high index of suspicion and promptly escalate treatment when necessary. Future research should focus on optimizing treatment protocols to improve outcomes in high-risk patients.

Availability of Data and Materials: The datasets generated and/or analyzed during the current study are not publicly available due to institutional data protection policies but are available from the corresponding author on reasonable request.

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Authors' Contributions: MUKK, RMS, and MIK conceptualized the study and supervised data collection. AQ and MTS contributed to clinical diagnosis and case verification. MAK and RMS handled microbiological data and imaging interpretation. MIK performed the data analysis and manuscript drafting. All authors reviewed and approved the final version of the manuscript.

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