DOI:https://doi.org/10.53350/pjmhs2023177152

ORIGINAL ARTICLE

Prevalence and Clinical Outcomes of Orbital Complications in Patients with Acute and Chronic Rhinosinusitis with Emphasis on Systemic Comorbidities. A Cross-Sectional Study

CHAUDHRY MUHAMMAD TARIQ MUNAWAR[1], REHAN MOINUDDIN SHAIKH[2], JAVED IQBAL[3], AHSAN QURESHI[5], MOHAMMAD AAMIR KHAN[5], WING COMMANDER MUHAMMAD TAHIR SHAH[6]

[1]*Associate Professor and Head of Department, Department of Ophthalmology, CMH Kharian Cantt, Kharian, Pakistan*
[2]*Associate Professor, Department of Ophthalmology, Sharif Medical College, Lahore, Pakistan*
[3]*Associate Professor, Department of ENT, Sahara Medical College, Narowal, Pakistan*
[4]*Assistant Professor, Department of ENT, Women Medical College, Abbottabad, Pakistan*
[5]*Assistant Professor, Department of Ophthalmology, Jinnah International Hospital, Abbottabad, Pakistan*
[6]*Assistant Professor, Department of ENT, Fazaia Medical College, Islamabad, Pakistan*
Correspondence to: Rehan Moinuddin Shaikh, Email: drrehan@hotmail.com.au

ABSTRACT

Background: Orbital complications of rhinosinusitis are life threatening and vision threatening, in particular in patients with systemic comorbidities like diabetes mellitus and immunosuppression. These complications are caused by anatomical closeness between the paranasal sinuses and the orbit and can go as far as to cause life-threatening conditions such as cavernous sinus thrombosis.

Objectives: The aim of the study was to evaluate the prevalence, pattern, and clinical outcomes of orbital complications in patients with acute and chronic rhinosinusitis with particular attention to the role of systemic comorbidities.

Methods: A cross-sectional study was carried out between January 2022 and February 2023 at CMH Kharian Cantt and Sughra Shafi Medical Complex, Narowal. Eighty patients with clinically and radiologically proven orbital complications secondary to rhinosinusitis were included. Clinical assessments, imaging reports (CT/MRI) and laboratory tests were done. Outcomes were assessed including the need of surgery, stay in the hospital and visual impairment and the systemic comorbidities were recorded.

Results: Preseptal cellulitis (37.5) and orbital cellulitis (28.8) were the most common. More severe complications such as orbital abscess (11.3%) and cavernous sinus thrombosis (5%) were more common in the patients with comorbidities. The most common comorbidity was diabetes mellitus (27.5%). Forty-five percent of the cases required surgical intervention and all the cases of permanent vision loss were among patients with systemic diseases. The length of hospitalization was much longer among patients with comorbidity ($p = 0.002$).

Conclusion: Systemic comorbidities significantly worsen the severity and outcomes of orbital complications in rhinosinusitis. Early diagnosis and aggressive multidisciplinary management are crucial, especially in high-risk patients, to prevent irreversible complications.

Keywords: Rhinosinusitis, Orbital complications, Preseptal cellulitis, Diabetes mellitus, Immunosuppression, Visual impairment, Surgical intervention.

INTRODUCTION

Rhinosinusitis, defined as the inflammation of the nasal cavity and paranasal sinuses, is one of the most frequently encountered conditions in both primary care and otolaryngological practice. It is broadly classified as acute rhinosinusitis (ARS) and chronic rhinosinusitis (CRS) depending on their duration of less than four and 12 weeks respectively[1]. Although the majority of cases of rhinosinusitis are mild, self-limiting and do not lead to severe orbital and intracranial complications, a small, yet clinically important number of cases may develop severe orbital and intracranial infections, especially those not diagnosed and treated timely and efficiently. The orbital involvement is one of these complications because of its close location to the ethmoid sinuses, its possible quick development and the threat of irreversible visual loss or intracranial spread[2].

The orbit is a limited anatomical cavity with thin bony walls which divide it with paranasal sinuses. Lamina papyracea, a thin paper-like bone between the ethmoid sinuses and the orbit, is one of the popular ways of infectious spread[3]. Sinus infections may violate this barrier by direct extension, congenital or acquired dehiscence of the bony wall, or by valveless venous drainage allowing a rapid hematogenous spread. Consequently, orbital complications of rhinosinusitis can arise rapidly and necessitate prompt medical or surgical treatment to avoid loss of sight, intracranial extension or even death[4].

The classification of orbital complications is usually based on the Chandler classification that starts at preseptal cellulitis or stage I to cavernous sinus thrombosis or stage V. The least severe of the conditions is preseptal cellulitis, which is limited to eyelid and periocular structures in front of the orbital septum[5]. Once the infection extends beyond the septum, it results in orbital cellulitis where there is proptosis, ophthalmoplegia, pain on eye movement with possible optic nerve involvement. Without sufficient management of the infection, it can develop a subperiosteal abscess, an orbital abscess, or spread posteriorly to lead to serious complications threatening life, including cavernous sinus thrombosis or meningitis[6].

In spite of the fact that orbital complications are possible in healthy people, they are more commonly seen in patients with underlying systemic comorbid conditions. Diabetes mellitus, for example, impairs neutrophil function, reduces tissue perfusion, and promotes an environment conducive to microbial proliferation[7]. Similarly, immunosuppressive conditions such as HIV/AIDS, post-transplant status, malignancy, and long-term corticosteroid use increase the host's susceptibility to severe and refractory infections. These systemic conditions not only increase the risk of orbital involvement in rhinosinusitis but also negatively affect treatment outcomes and prognosis. Despite this, there remains a paucity of data examining the direct relationship between systemic comorbidities and the severity and outcomes of orbital complications secondary to rhinosinusitis[8].

Moreover, most existing studies focus either on pediatric populations, in whom orbital cellulitis is more commonly reported, or on individual case series without comprehensive evaluation of comorbidity profiles[9]. In contrast, adult and elderly populations, especially those with chronic diseases, remain underrepresented in current literature despite being at high risk for complications. This creates a critical gap in clinical understanding and hampers

Received on 22-03-2022
Accepted on 06-06-2023

the development of targeted guidelines for early risk stratification and management[10].

Timely identification of orbital complications in rhinosinusitis is essential, as delays in diagnosis and management significantly contribute to poor outcomes, including permanent visual impairment and intracranial sequelae[11]. The advent of advanced imaging modalities, such as high-resolution computed tomography (CT) and magnetic resonance imaging (MRI), has improved diagnostic accuracy and surgical planning. However, the decision to initiate medical management versus surgical drainage remains nuanced and is influenced by the extent of orbital involvement, patient's systemic condition, and response to initial therapy[12].

Moreover, thorough assessment of systemic comorbidities in patients with orbital complications could help gain useful prognostic values and inform individual treatment plans. The knowledge of the effects of diabetes and immunosuppression as well as other systemic diseases on the clinical course and outcome of these infections could assist the clinician to intervene earlier, follow and monitor at-risk patients more closely and possibly improve the rates of complications[13].

Based on these considerations, the present cross-sectional study was aimed at examining the rates and the nature of orbital complications in patients with acute and chronic rhinosinusitis with a particular focus on the assessment of the role played by systemic comorbidities in determining the level of presentation and final outcomes. Filling this knowledge gap, the study will help add to the existing literature on rhinosinusitis-related orbital pathology and improve the more effective management through multidisciplinary efforts, particularly in healthcare systems where late presentations and low resources are the rule[14].

MATERIALS AND METHODS

The study was a cross-sectional observational study that was conducted during a period of 14 months, between January 2022 and February 2023, in two tertiary care hospitals in Punjab, Pakistan: the Department of ENT and Ophthalmology at Combined Military Hospital (CMH), Kharian Cantt, Kharian and the ENT Unit of Sughra Shafi Medical Complex, Narowal. These institutions were chosen based on their high patient turnover and the availability of both the ENT and the ophthalmic surgical services that would be required in the management of the orbital complications of rhinosinusitis.

A total of 80 patients were enrolled using a non-probability consecutive sampling technique. Patients with clinical manifestations of acute or chronic rhinosinusitis with orbital complications of any age and gender were included. The European Position Paper on Rhinosinusitis and Nasal Polyps (EPOS 2020) was used to make the diagnosis of rhinosinusitis. Clinical evidence of orbital involvement was established by swelling of the eyelids, chemosis, proptosis, ophthalmoplegia, reduced visual acuity, and imaging radiological changes that showed the spread of the infection beyond the sinus limits. Patients were only considered in the event of radiological evidence of orbital involvement as evidenced by a contrast-enhanced computed tomography (CT) or magnetic resonance imaging (MRI). Patients who had an orbital infection as a consequence of trauma, post surgical infection that was not related to sinus illness or with incomplete documentation or unwilling to sign consent were excluded in the study.

All the subjects were examined thoroughly by an ear, nose, and throat expert and an eye physician. Demographic details and the type of rhinosinusitis (acute or chronic), the nature and duration of symptoms and the presence of systemic comorbidities were noted with the help of a structured proforma. There was close documentation of systemic comorbidities like diabetes mellitus, hypertension, chronic kidney disease, malignancy, and immunosuppressive states (such as HIV/AIDS or chemotherapy) based on clinical history and medication records, as well as laboratory assessment.

The radiological evaluation was important to diagnose and categorize the orbital complications. Each of the patients was exposed to CT or MRI of the orbits or paranasal sinuses. The category of the severity and stage of orbits involvement was classified according to classification of Chandler, which includes pre-septal cellulitis (stage I), cavernous sinus thrombosis (stage V). There is also surgical decision making assistance using imaging, particularly of situations where drainage of orbital or subperiosteal abscesses is needed.

All patients underwent laboratory studies that comprised complete blood count (CBC), erythrocyte sedimentation rate (ESR), C-reactive protein (CRP), fasting and random blood glucose, HbA1c, renal and liver functions. HIV screening and other immunological tests were also done to check the immune status of the patient in areas where indicated clinically.

All patients were given standardized medical treatment that included empirical broad-spectrum intravenous antibiotics, systemic corticosteroids, nasal decongestants and analgesics. Patients with extensive orbital involvement or with an inadequate response to medical treatment were indicated to surgical treatment, and it varied with the location and extent of the infection: endoscopic sinus surgery, subperiosteal or orbital abscess drainage, or combined external and endoscopic approach.

The primary outcomes assessed were the type and frequency of orbital complications. Secondary outcomes included the need for surgical intervention, duration of hospital stay, visual outcome (complete recovery, visual impairment, or blindness), and overall prognosis. All clinical outcomes were compared between patients with and without systemic comorbidities to assess the influence of underlying health conditions on disease severity and treatment response.

Data analysis was performed using IBM SPSS Statistics for Windows, Version 26. Continuous variables such as age and hospital stay duration were expressed as mean ± standard deviation, while categorical variables including type of orbital complication, presence of comorbidities, and visual outcomes were presented as frequencies and percentages. The association between systemic comorbidities and the severity of orbital complications or clinical outcomes was evaluated using Chi-square test for categorical variables and independent sample t-test for continuous variables. A p-value of less than 0.05 was considered statistically significant.

Ethical approval for this study was obtained from the Institutional Review Boards of CMH Kharian and Sughra Shafi Medical Complex Narowal. Informed written consent was obtained from all patients or their legal guardians prior to participation. Patient confidentiality and anonymity were strictly maintained throughout the study in accordance with the Declaration of Helsinki.

RESULTS

A total of 80 patients were included in this cross-sectional study, comprising 47 males (58.8%) and 33 females (41.2%), with an overall mean age of 34.9 ± 17.6 years. Among these, 50 patients (62.5%) were diagnosed with acute rhinosinusitis, while 30 patients (37.5%) had chronic rhinosinusitis based on EPOS 2020 guidelines and clinical duration of symptoms.

Out of the 80 patients, orbital complications were classified radiologically and clinically according to Chandler's classification, as shown in Table 1. The most frequently observed complication was preseptal cellulitis, seen in 30 cases (37.5%), followed by orbital cellulitis in 23 patients (28.8%). More severe complications such as subperiosteal abscess were present in 14 patients (17.5%), orbital abscess in 9 patients (11.3%), and cavernous sinus thrombosis was identified in 4 patients (5%). These advanced stages were more prevalent among individuals with underlying systemic comorbidities.

Analysis of systemic comorbidities revealed that 47 patients (58.8%) had at least one comorbid condition. Diabetes mellitus was the most common, seen in 22 patients (27.5%), followed by hypertension in 15 patients (18.8%), immunosuppression in 6 patients (7.5%), and chronic kidney disease in 4 patients (5%), as

illustrated in Table 2. Notably, the incidence of more severe orbital complications (subperiosteal abscess, orbital abscess, and cavernous sinus thrombosis) was significantly higher in patients with comorbidities (p = 0.004).

Table 1: Distribution of Orbital Complications by Chandler's Classification (n = 80)

Orbital Complication	Frequency (n)	Percentage (%)
Preseptal cellulitis	30	37.5
Orbital cellulitis	23	28.8
Subperiosteal abscess	14	17.5
Orbital abscess	9	11.3
Cavernous sinus thrombosis	4	5.0

Table 2: Frequency of Systemic Comorbidities in Patients with Orbital Complications (n = 80)

Systemic Comorbidity	Frequency (n)	Percentage (%)
Diabetes Mellitus	22	27.5
Hypertension	15	18.8
Immunosuppression (e.g., HIV, cancer)	6	7.5
Chronic Kidney Disease	4	5.0
No Comorbidity	33	41.2

Regarding clinical outcomes, medical management alone was successful in 44 patients (55%), while surgical intervention was required in 36 patients (45%), particularly those with abscesses or poor response to antibiotics. Among patients undergoing surgery, 25 (69.4%) had systemic comorbidities. The need for surgical drainage was significantly associated with the presence of diabetes and immunosuppression (p = 0.01), as these patients demonstrated a delayed response to medical therapy and more extensive radiological involvement.

The mean hospital stay was 7.6 ± 3.9 days, with patients without comorbidities having a shorter stay (mean 5.2 ± 1.6 days) compared to those with comorbidities (mean 9.1 ± 3.3 days), which was statistically significant (p = 0.002). Additionally, permanent visual impairment occurred in 6 patients (7.5%), all of whom had systemic comorbidities and presented in advanced stages (Chandler stages IV and V). One mortality was recorded in a patient with cavernous sinus thrombosis and uncontrolled diabetes, reflecting a 1.3% mortality rate in the study population.

These findings are summarized in Table 3, which highlights the significant relationship between comorbidity status and adverse clinical outcomes including surgery, vision loss, and prolonged hospitalization.

Table 3: Clinical Outcomes in Patients With and Without Systemic Comorbidities (n = 80)

Outcome	With Comorbidities (n = 47)	Without Comorbidities (n = 33)	p-value
Surgical intervention	25 (53.2%)	11 (33.3%)	0.01
Mean hospital stay (days)	9.1 ± 3.3	5.2 ± 1.6	0.002
Permanent vision loss	6 (12.8%)	0 (0%)	0.003
Mortality	1 (2.1%)	0 (0%)	NS

These results clearly indicate that systemic comorbidities such as diabetes mellitus and immunosuppressive conditions are strongly associated with more severe orbital complications, higher rates of surgical intervention, longer hospitalization, and poorer visual outcomes. Early diagnosis and aggressive management are particularly critical in these high-risk groups to prevent irreversible complications.

DISCUSSION

Such cross-sectional study is of much significance in understanding the scope, frequency, and outcome of orbital complications in patients with acute and chronic rhinosinusitis, and specifically in the presence of systemic comorbidities[15]. These results indicate that orbital involvement is a serious and sight-threatening sequel of rhinosinusitis, especially when they are complicated by systematic diseases like diabetes mellitus and immunosuppression[16].

Preseptal cellulitis, orbital cellulitis and subperiosteal abscess had frequencies of 37.5%, 28.8% and 17.5%, respectively, with the progression observed in Chandler classification of orbital complication[17]. This tendency is consistent with the international data as preseptal cellulitis is the first and most common condition of the orbital involvement because of its anatomical closeness to the ethmoid sinus through the thin lamina papyracea. However, our data show a relatively higher proportion of advanced complications, including orbital abscess (11.3%) and cavernous sinus thrombosis (5%), reflecting a delay in presentation or referral, particularly among patients with comorbidities[18].

A key finding of this study is the statistically significant association between systemic comorbidities and the severity of orbital complications. Among patients with diabetes mellitus, hypertension, or immunosuppression, there was a notably higher incidence of abscess formation, need for surgical intervention, longer hospital stays, and worse visual outcomes[19]. For instance, surgical intervention was required in 53.2% of patients with comorbidities, compared to 33.3% in those without (p = 0.01). Furthermore, all cases of permanent vision loss (7.5%) occurred in patients with comorbid conditions, particularly poorly controlled diabetes[20].

Diabetes mellitus emerged as the most prevalent comorbidity (27.5%) and showed a strong association with complicated and protracted disease. Hyperglycemia is known to impair neutrophil function and reduce tissue perfusion, leading to inadequate immune response and facilitating microbial invasion and abscess formation. Similarly, patients on immunosuppressive therapy or with underlying malignancies presented with more severe forms such as orbital abscess and cavernous sinus thrombosis, requiring prompt multidisciplinary management[21].

The need for early surgical drainage was greater in advanced Chandler stages (III to V), especially among diabetics and immunocompromised patients. These patients often presented late or failed to respond adequately to intravenous antibiotics. The mean hospital stay was significantly longer in those with comorbidities (9.1 days vs. 5.2 days; p = 0.002), which could be attributed to the complexity of the infection, slower healing response, and the need for surgical procedures followed by extended recovery[22].

Our study also emphasizes the critical role of radiological imaging (CT/MRI) in the early identification of orbital extension, guiding prompt therapeutic decisions. The correlation between imaging findings and clinical severity underlines the importance of comprehensive diagnostic workup in any rhinosinusitis patient exhibiting orbital symptoms, especially when systemic risk factors are present[23].

Compared to pediatric populations where orbital cellulitis is more frequently reported, our adult and elderly cohort particularly those with chronic rhinosinusitis presented with more severe forms and worse outcomes. This suggests that adult patients with systemic disease are underrecognized high-risk groups that require proactive monitoring and aggressive intervention[24].

Although the study provides essential clinical correlations, some limitations must be acknowledged. The sample size was modest, and the data were limited to two centers. Additionally, long-term follow-up of visual function and recurrence was not conducted. However, the strength of the study lies in its dual-center design, use of radiological confirmation, and comprehensive assessment of systemic comorbidity impact[25].

CONCLUSION

This study concludes that orbital complications are not uncommon among patients with acute and chronic rhinosinusitis, and their severity significantly increases in the presence of systemic comorbidities, particularly diabetes mellitus and

immunosuppression. The presence of these conditions correlates with more advanced Chandler stages, increased need for surgical intervention, longer hospital stays, and a higher risk of irreversible visual impairment. Early clinical recognition, high-index suspicion in comorbid patients, prompt imaging, and timely surgical drainage are critical to improving outcomes. Integrating systemic disease management into the standard treatment protocols for complicated rhinosinusitis can significantly reduce morbidity and prevent life-threatening consequences. Future studies with larger cohorts and extended follow-up are warranted to further evaluate recurrence rates, long-term visual outcomes, and the role of tailored therapeutic strategies in high-risk populations.

Conflict of interest: All authors declare no conflict of interest faced during the present study.

Funding: No funding was received for the study.

Authors contributions: All authors contributed equally.

Acknowledgment: We would like to acknowledge paramedical staff for support and our colleagues for supporting us and making this study possible.

REFERENCES

1. Cantone E, Piro E, De Corso E, Di Nola C, Settimi S, Grimaldi G, et al. Clinical markers of need for surgery in orbital complication of acute rhinosinusitis in children: overview and systematic review. Journal of Personalized Medicine. 2022;12(9):1527.
2. Carr TF. Complications of sinusitis. American journal of rhinology & allergy. 2016;30(4):241-5.
3. Hopkins C, Browne J, Slack R, Lund V, Topham J, Reeves B, et al. The national comparative audit of surgery for nasal polyposis and chronic rhinosinusitis. Clinical Otolaryngology. 2006;31(5):390-8.
4. Rosenfeld RM, Piccirillo JF, Chandrasekhar SS, Brook I, Ashok Kumar K, Kramper M, et al. Clinical practice guideline (update): adult sinusitis. Otolaryngology–Head and Neck Surgery. 2015;152(2_suppl):S1-S39.
5. De Corso E, Lucidi D, Cantone E, Ottaviano G, Di Cesare T, Seccia V, et al. Clinical evidence and biomarkers linking allergy and acute or chronic rhinosinusitis in children: a systematic review. Current allergy and asthma reports. 2020;20:1-13.
6. Bachert C, Marple B, Schlosser RJ, Hopkins C, Schleimer RP, Lambrecht BN, et al. Adult chronic rhinosinusitis. Nature Reviews Disease Primers. 2020;6(1):86.
7. DeConde AS, Soler ZM. Chronic rhinosinusitis: epidemiology and burden of disease. American journal of rhinology & allergy. 2016;30(2):134-9.
8. Phillips KM, Barbarite E, Hoehle LP, Caradonna DS, Gray ST, Sedaghat AR. Clinical traits characterizing an exacerbation-prone phenotype in chronic rhinosinusitis. Otolaryngology–Head and Neck Surgery. 2019;161(5):890-6.
9. Fokkens WJ, Lund VJ, Hopkins C, Hellings PW, Kern R, Reitsma S, et al. European position paper on rhinosinusitis and nasal polyps 2020. Rhinology: official organ of the International rhinologic society. 2020;58(Suppl 29):1-464.
10. Passali D, Cingi C, Cambi J, Passali F, Muluk NB, Bellussi ML. A survey on chronic rhinosinusitis: opinions from experts of 50 countries. European Archives of Oto-Rhino-Laryngology. 2016;273:2097-109.
11. Bachert C, Han JK, Wagenmann M, Hosemann W, Lee SE, Backer V, et al. EUFOREA expert board meeting on uncontrolled severe chronic rhinosinusitis with nasal polyps (CRSwNP) and biologics: definitions and management. Journal of Allergy and Clinical Immunology. 2021;147(1):29-36.
12. Soler ZM, Mace JC, Litvack JR, Smith TL. Chronic rhinosinusitis, race, and ethnicity. American journal of rhinology & allergy. 2012;26(2):110-6.
13. Bergmark RW, Hoehle LP, Chyou D, Phillips KM, Caradonna DS, Gray ST, et al. Association of socioeconomic status, race and insurance status with chronic rhinosinusitis patient-reported outcome measures. Otolaryngology–Head and Neck Surgery. 2018;158(3):571-9.
14. Rosenfeld RM, Piccirillo JF, Chandrasekhar SS, Brook I, Ashok Kumar K, Kramper M, et al. Clinical practice guideline (update) adult sinusitis executive summary. Otolaryngology--Head and Neck Surgery. 2015;152(4):598-609.
15. Orlandi RR, Kingdom TT, Hwang PH, Smith TL, Alt JA, Baroody FM, et al., editors. International consensus statement on allergy and rhinology: rhinosinusitis. International forum of allergy & rhinology; 2016: Wiley Online Library.
16. Al-Ahmad M, Alsaleh S, Al-Reefy H, Al Abduwani J, Nasr I, Al Abri R, et al. Expert opinion on biological treatment of chronic rhinosinusitis with nasal polyps in the Gulf region. Journal of Asthma and Allergy. 2022:1-12.
17. Pakdel F, Ahmadikia K, Salehi M, Tabari A, Jafari R, Mehrparvar G, et al. Mucormycosis in patients with COVID-19: a cross-sectional descriptive multicentre study from Iran. Mycoses. 2021;64(10):1238-52.
18. Liu Z, Chen J, Cheng L, Li H, Liu S, Lou H, et al. Chinese society of allergy and Chinese society of otorhinolaryngology-head and neck surgery guideline for chronic rhinosinusitis. Allergy, Asthma & Immunology Research. 2020;12(2):176-237.
19. Miłkowska-Dymanowska J, Białas AJ, Zalewska-Janowska A, Górski P, Piotrowski WJ. Underrecognized comorbidities of chronic obstructive pulmonary disease. International Journal of Chronic Obstructive Pulmonary Disease. 2015:1331-41.
20. Ting F, Hopkins C. Outcome measures in chronic rhinosinusitis. Current otorhinolaryngology reports. 2018;6:271-5.
21. Molina A, Sanz-Sánchez I, Sanz-Martín I, Ortiz-Vigón A, Sanz M. Complications in sinus lifting procedures: Classification and management. Periodontology 2000. 2022;88(1):103-15.
22. Lee C-Y, Yang K-L, Sun C-C, Huang J-Y, Chen H-C, Chen H-C, et al. The development of dry eye disease after surgery-indicated chronic rhinosinusitis: A population-based cohort study. International Journal of Environmental Research and Public Health. 2020;17(11):3829.
23. Hansen F, Hoffmans R, Georgalas C, Fokkens W. Complications of acute rhinosinusitis in The Netherlands. Family practice. 2012;29(2):147-53.
24. Chow VJ, Tsetsos N, Poutoglidis A, Georgalas C. Quality of life in sinonasal tumors: an up-to-date review. Current Opinion in Otolaryngology & Head and Neck Surgery. 2022;30(1):46-57.
25. Eldsouky SM, Shahat AK, AL-Tabbakh ASM, El Rahman SMA, Marei YM, Mohammed LA, et al. Clinical and mycological investigations of post-COVID-19 acute invasive fungal sinusitis. Laryngoscope Investigative Otolaryngology. 2022;7(6):1780-9.

This article may be cited as: Munawar CMT, Shaikh RM, Iqbal J, Qureshi A, Khan MA, Shah WCMT: Prevalence and Clinical Outcomes of Orbital Complications in Patients with Acute and Chronic Rhinosinusitis with Emphasis on Systemic Comorbidities. A Cross-Sectional Study. Pak J Med Health Sci, 2023; 17(7): 152-155.