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Risk Factors for Orbital Complication in Odontogenic Rhinosinusitis

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Abstract

Background : Orbital involvement is the most common complication in rhinosinusitis presenting about 60–75%. The manifestation of orbital complications such as eyelid edema, proptosis, eye movement disorder and loss of vision. The potential risk factors for developing complications are described in several studies. The purpose of this study was to examine the risk factors for orbital complication in odontogenic rhinosinusitis.
Methods : A retrospective case control study of 34 patients from July 2022 to July 2023 based on medical records. The subjects were classified into two groups, the case group involving odontogenic rhinosinusitis patients with orbital complication and the control group involving patients without orbital complications. Risk factors were sex, onset of odontogenic sinusitis, sinonasal symptoms, diabetes, histopathological findings, laboratory findings and CT scan images of sinus. The characteristics of orbital complications and the types of pathogenic bacteria cultivated were recorded.
Results : There number of patients in each group were 17, with the female to male ratio of 2,4:1, aged 8 to 81 years were enrolled in this study. The most common orbital complication was sub periosteal abscess (41%). We found 64% positive bacterial growth from tissue culture dominated by *Staphylococcus sp.* (54.5%). Histopathological examination showed the main inflammatory cell of the sinus mucosal epithelium was neutrophil in both groups. The logistic regression test showed that the risk factors for orbital complication were absolute neutrophil count *p* 0.008, OR 81.062, mucopurulent discharge p 0.009, OR 0.006 and sinus involvement *p* 0.027, OR 0.152.
Conclusion : Orbital complications were associated with sinus involvement with main symptom involving mucopurulent discharge and higher absolute neutrophil count.

Keywords : orbital complications, odontogenic rhinosinusitis, risk factor

INTRODUCTION

Odontogenic rhinosinusitis refers to bacterial maxillary sinusitis, with or without extension to other paranasal sinuses, secondary to either adjacent infectious maxillary dental pathology, or following complications from dental procedures. Odontogenic rhinosinusitis could account for 25% to 40% of all chronic maxillary sinusitis, and 45% to 75% of unilateral maxillary sinus opacification on computed tomography (CT) images.[1] The incidence of odontogenic rhinosinusitis in Indonesia is from 10% to 36%.[2]

Odontogenic rhinosinusitis may cause complications of orbital, intracranial, and osseus infections. These complications can occur ranging from acute rhinosinusitis (ARS) to chronic rhinosinusitis (CRS) and tend to be associated with ARS in pediatric patients and CRS in adult patients. Among the types of complication, 60% to 80% are orbital, 15% to 20% are intracranial, and 3% to 10% are bone complications.[3] A retrospectives study in Bucharest shows that during a five-year period, 25,48% odontogenic patients were admitted to the ENT department. Of the 517 patients with odontogenic sinusitis, 46 patients were diagnosed with occlusal-orbital complications (8,89%).[4]

Odontogenic infections usually gain access to the orbital cavity through the maxillary sinus, associated facial vasculature, deep temporal space, pterygopalatine fossa, and inferior orbital fissure. Orbital complications classified anatomically by the orbital septum include pre-septal cellulitis or abscess, post-septal (orbital) cellulitis, subperiosteal abscess, orbital abscess (intraconal), and cavernous sinus thrombosis.[5]

Regarding sinus treatment for complicated odontogenic sinusitis, only 50% of cases in the literature were treated with endoscopic sinus surgery (ESS), with external approaches being performed in 40% of cases.[3]

While odontogenic sinusitis diagnosis and management have been discussed in recent review or consensus articles, these have mainly focused on uncomplicated odontogenic sinusitis. Complicated odontogenic sinusitis is rarely described.

METHODS

This was a retrospective case-control study conducted on rhinosinusitis patients who were admitted to Kariadi General Hospital, a tertiary hospital in Central Java, Indonesia, between 2022 and 2023. The study population was odontogenic rhinosinusitis patients with and without orbital complications defined based on EPOS criteria and confirmed using computed tomography of sinuses and orbits. Exclusion criteria involved patients with a history of nasal or orbital surgery such as functional endoscopic sinus surgery (FESS), previous trauma or fractures to the orbit or nasal cavity, and known orbital anomalies, malignancy, dacryocystitis, or postoperative infection. This study has been approved by the Health Research Ethics Committee of Kariadi General Hospital.

The patient data were obtained from the electronic medical records of Kariadi General Hospital. The retrieved data included the diagnosis of odontogenic rhinosinusitis and informations regarding age, sex, onset of odontogenic sinusitis, sinonasal symptoms, concomitant diseases, microbiology culture, histopathological findings, laboratory findings and CT scan images of the sinus. The CT scan images were evaluated by radiologist who specializes in this field.

Orbital complications were evaluated using the Chandler's classification system, which categorizes types of orbital cellulitis into five different stages. These stages included (1) pre-septal cellulitis, (2) post-septal cellulitis (orbital cellulitis), (3) subperiosteal abscess, (4) orbital abscess, and (5) cavernous sinus thrombosis. The sample size of each group was calculated using the matched case control method, there were 17 subjects in each group.

We analyzed clinical and demographic data using descriptive statistics and IBM® SPSS® Statistics version 25. We used Fisher's exact test or chi-square test for categorical variables, the t test for comparisons of means, and the Mann-Whitney U test for nonparametric continuous variables. Spearman's correlation was used to assess associations between variables. We considered $p \leq 0.05$ to indicate statistical significance.

RESULTS

Thirty-four patients were included in the study. Female patients were more (70.6%) than males (29.4%) with the female to male ratio was 2,4:1. Patient age ranged from 8 to 80 years, with a mean ± SD of 42.5 ± 18.28 years. There were 4 (23%) patients aged <18 years, 10 (58%) patients aged 18 to 60 years and 3 (9%) patients with orbital complications. The presence of orbital complications was pre-septal cellulitis (2 patients), orbital cellulitis (6 patients), subperiosteal abscess (7 patients), orbital abscess (2 patients) and cavernous sinus thrombosis (1 patient). Clinical symptoms for orbital complications were mostly edema (82%), hyperemia (59%), pain (59%), visual impairment (52%), ptosis (35%), and ophthalmoplegia (18%). The correlation between case and control groups are summarized in Table 1.

Microbiological examination was only performed on the case group, showing that 64% of patients had positive bacterial growth from tissue culture, consisting of gram-positive bacteria (32.3%) and gram-negative bacteria (14.7%). The results of bacterial culture were *Staphylococcus sp*. (54.5%), *Peptostreptococcus sp*, *Streptococcus sp*, *Burkholderia cepacia*, *Enterobacter cloacae*, and *Pediococcus pentasaceus*. We also found fungi in 2 cases, *Candida cifferrii* and *Mucor Sp*.

TABLE 1
The correlation between case and control groups

Variables		Groups				*p*	OR (95% CI)
		Case		Control			
		n	%	n	%		
Sex	Male	7	41.2	8	47.1	1.000[α]	0.89 (0.45 – 1.77)
	Female	10	58.8	9	52.9		
Leukocyte	Leukocytosis	10	58.8	4	23.5	0.081[α]	2.04 (1.03 – 4.04)
	Normal	7	41.2	13	76.5		
ANC	>7000	10	58.8	3	17.6	0.034[α*]	2.31 (1.18 – 4.53)
	≤7000	7	41.2	14	82.4		
Sinusitis	Maxilla	15	88.2	17	100	0.242[b]	0.45 (0.32 – 0.68)
	Ethmoid	16	94.1	12	70.6	0.087[b]	3.43 (0.56 – 21.11)
	Frontal	8	47.1	5	29.4	0.480[α]	1.44 (0.75 – 2.76)
	Sphenoid	8	47.1	2	11.8	0.060[α]	2.13 (1.17 – 3.90)
Sinus involvement	Maxilla	1	5.9	5	29.4	0.046[c*]	–
	Maxilla + ethmoida	5	29.4	5	29.4		
	Maxilla+ethmoida+frontal/sphenoid	8	47.1	7	41.2		
	Pansinusitis	3	17.6	0	0		
Onset	<12 weeks	3	17.6	2	11.8	0.500[b]	1.24 (0.55 – 2.79)
	≥12 weeks	14	82.4	15	88.2		
Tissue inflammatory	Neutrophyls	15	88.2	13	76.5	0.328[b]	1.61 (0.49 – 5.25)
	Eosinophyls	2	11.8	4	23.5		
Symptoms	Nasal obstruction	11	64.7	13	76.5	0.707[α]	0.76 (0.39 – 1.49)
	Mucopurulent discharge	7	41.2	15	88.2	0.012[α*]	0.38 (0.20 – 0.74)
	Anosmia	5	29.4	5	29.4	1.000[α]	1.00 (0.45 – 2.09)
	Facial pain	13	76.5	12	70.6	0.005[α*]	1.17 (0.51 – 2.66)
Comorbid	Diabetes	6	35.3	4	23.5	0.707[α]	1.31 (0.67 – 2.55)

ANC: Absolute neutrophil count. Statistical analysis a Continuity Correction, [b] Fisher's exact, [c] Mann-Whitney*p<0.05 significance

The onset of odontogenic rhinosinusitis in both groups were mostly more than 12 weeks, and categorized as chronic rhinosinusitis. The main symptom of odontogenic rhinosinusitis was facial pain, followed by nasal congestion, mucopurulent discharge and anosmia. Only mucopurulent discharge has significance correlation with orbital complication, with mild odd ratio.

Histopathological examination showed neutrophils as the main inflammatory cell of the sinus mucosa, both in the case (88.2%) and control (76.5%) groups. In both groups, diabetes was not dominance and there was no significant difference between two groups.

Computerized tomography of the paranasal sinus showed the predominance of sinus opacities in the maxillary and ethmoid sinuses in both case and control groups. However, statistical analysis showed no significant correlation with orbital complications. We classified the severity of the paranasal sinus involvement based on tomography computer, showing that the involvement of three sinuses (either combination of maxilla, ethmoid and frontal or maxilla, ethmoid and sphenoid sinuses) was the most common in both case and control groups. Pansinusitis was only found in case group. There was a significant correlation in statistical analysis.

TABLE 2
The risk factors for orbital complications in odontogenic rhinosinusitis

Variables	*p*	OR	95% CI
Leucocytosis	0.460	3.736	0,113 – 123,585
ANC	0.008*	81.062	3,156 – 2081,933
Ethmoid sinus	0.473	0.173	0,001 – 20,923
Sinus involvement	0.027*	0.152	0,029 – 0,804
Mucopurulent discharge	0.009*	0.006	0,000 – 0,280

*p<0.05 significance

The laboratory findings show that leukocytosis was most common in the case group. There was no significant correlation between leukocytosis and orbital complications. The absolute neutrophil count in case group was higher than in the control group, and there was a significant correlation with orbital complications.

The logistic regression test showed that ANC, sinus involvement and mucopurulent discharge had a *p value* <0.05. It can be concluded that ANC, sinus involvement and mucopurulent discharge were the dominant factors influencing the orbital complication.

DISCUSSION

Odontogenic sinusitis is one of the most common causes of unilateral sinus diseases, and certain odontogenic bacteria are more common in odontogenic sinusitis than in rhinosinusitis, previous studies of rhinosinusitis complications could have overlooked odontogenic sinusitis as a cause of orbital complications. Complicated odontogenic sinusitis affected all ages and sexes in this study.

Odontogenic sinusitis is usually found in patients aged between 40 and 60 years and has predominance in female compared to male, with a ratio of 1:1.33 in previous studies.[6] The mean age of subjects was 42.5 years and female was more frequent than male, thus consistent with previously published data reporting an older mean age. Previous studies have reported orbital and intracranial complications due to rhinosinusitis mostly in a pediatric population due to imperfect bone growth and open cranial sutures as predilection sites for the spread inflammation.[7,8] However, in retrospective study in Taiwan showed no significant difference of orbital complication in children (42.2%) and adults (57.8%) patients.[9] The orbital complications were reported in 44,1% of invasive fungal rhinosinusitis in adult population, and were higher in female than male (61% : 39%).[10] A retrospective study in Bucharest shows that the orbital complications in adult odontogenic sinusitis mostly occurred in elderly (44,4%).[11] The subjects of our study were odontogenic rhinosinusitis, a rare condition in pediatric.[12] Some studies reported that odontogenic sinusitis was usually found in patients aged between 40 and 60 years old and was slightly more frequent in women: 57.7% than men 42.82%, with a ratio of 1:1,33.[6] This is in line with our study showing that our subjects mostly aged 18 to 60 years.

The onset of odontogenic sinusitis in our study was mostly more than 12 weeks in both groups. Odontogenic sinusitis can be classified as acute and chronic, in which the predominance symptoms in acute phase are fever, headache and suborbital pain. It can be developed into chronic if disease is unrecognized nor controlled. Most odontogenic sinusitis is in chronic condition as many patients are not aware of the symptoms of sinusitis.[13] Patients with acute condition was found in children and young adults. The rate of complications varies from 3% to 20% in patients hospitalized with ABRS.[14]

Sinonasal symptoms of odontogenic sinusitis were unilateral and consistent with cardinal symptoms of rhinosinusitis such as nasal congestion, anterior or posterior nasal discharge, facial pain and anosmia or hyposmia.[15] Other symptoms include purulent discharge in the oral cavity and dental pain.[16] In acute phase, the predominance symptoms are foul odor, and head or facial pain. The cardinal symptoms in chronic odontogenic sinusitis are malodorous scent with unilateral facial pressure, that is confirmed by the presence of pus in the middle meatal, mucosal swelling or protrusion of uncinate process and opacification of the unilateral sinus in computed tomography images. Unilateral maxillary sinusitis could be related to dental pathology and odontogenic sinusitis was found in 45–72% of unilateral maxillary opacification in computed tomography images.[13] In our study, mucopurulent discharge was the only symptom significantly correlated with orbital complications.

The main complain of orbital complications was edema (82%), while the other symptoms were hyperemic (59%), pain (59%), visual impairment (52%), ptosis (35%), and ophthalmoplegia (18%). This result is consistent with a systematic review reporting three most frequently

symptoms found in literature involving periorbital edema (100%), ocular or facial pain (82.9%) and limited ocular movements (82.9%).[17] Our study showed the most common orbital complication involving subperiosteal abscess and orbital cellulitis. This result is similar with previous study examining odontogenic orbital cellulitis, reporting that the two most frequent types found in the literature corresponded to an intra-orbital abscess (Chandler stage IV) (42.9% of cases) and subperiosteal abscess (Chandler stage III) (25.7% of cases).[17] Other study shows the three most frequent symptoms involving subperiosteal abscess (22%), post-septal cellulitis (14%) and orbital abscess (8%).[3] In contrast to previous study, it was reported that pre septal cellulitis was the most common orbital complication,[4] and severe complications can occurred in older patients or delay in hospitalization.[18]

Odontogenic sinusitis is a polymicrobial infection in which bacteria, predominanly anaerobic species, from both oral cavity and upper respiratory system are involved. Anaerobic bacteriological flora is the most common cause of chronic OMS, while the main flora is mixed in patients with acute OMS.[19] An interesting finding was the fact that although we collected samples for bacteriological examination from sinus and orbital secretions at admission and during surgery, the laboratory did not find pathogens from 6 to 17 cases (34%). This may be related to the use of broad-spectrum antibiotic therapy at diagnosis and prior to sampling. In 64% of positive-bacterial growth from tissue culture, we found 32.3% of gram-positive bacteria and 14.7% of gram-negative bacteria.

The microbiological results in this study shows the most common germs were *Streptococcus sp*. (17.6% of cases) and *Staphylococcus sp*. (5.8% of cases). Similar results from previous study shows the most common germs found are commensal streptococcus of the oral cavity or anaerobic bacteria (25.7% of cases), and coagulase-negative staphylococcus (22.9% of cases).[17] The microbiological findings in acute odontogenic sinusitis showed aerobic bacteria such as *Hemolytic Streptococcus alpha*, *microaerophilic streptococci*, *Staphylococcus aureus*, and *Streptococcus pyogenes*, and also anaerobes such as Gram-negative bacilli, *Pepto-streptococcus*, *Fusobacterium sporulatum*, and *Propionibacterium acnes*. The most frequent germs of chronic odontogenic sinusitis are anaerobes such as Gram-negative bacilli, *Pepto-streptococcus*, and *Fusobacterium spp*., while aerobes can also be encountered in some cases, such as *Streptococcus c. alpha-hemolytic*, *Streptococcus c. microhemolytic*, *Staphylococcus aureus*.[6] Chronic odontogenic sinusitis is strongly associated with *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Haemophilus influenza* and *Moraxella catarrhalis*.[20]

Tissue inflammation from nasal mucosal biopsy was dominated by neutrophilic inflammation, either in case (51.9%) and control group (48.1%). It may be because of the mucosal inflammation in odontogenic sinusitis due to by bacterial infection. Severe periodontal disease can lead to inflammation of the maxillary mucosa and ultimately odontogenic sinusitis. This is due to a significant increase in pathogenic bacteria, by-products and inflammatory cytokines which reach the sinus mucosa directly through diffusion or indirectly through the lymph vessels, resulting in inflammation of the sinus mucosa. One of the causes of odontogenic sinusitis is endodontic infection, where bacterial invasion occurs in the pulp chamber and root apex developing into an inflammation or infection in the apical periodontium known as apical periodontitis.[20]

The extents of sinus opacities are mostly in involved maxilla, ethmoid and either frontal or sphenoid sinuses, and similar in both groups. Previous retrospective studies assessing paranasal sinus involvement in rhinosinusitis reported an equal involvement of frontal, maxillary and ethmoid sinuses in rhinosinusitis patients with orbital and intracranial complications, while others found no difference among all paranasal sinuses.[7] However, in comparison with rhinogenic rhinosinusitis, the involvement of the posterior ethmoid sinus and sphenoid sinusitis is rare in odontogenic sinusitis.[21] In our study, the involvement of paranasal sinuses were statistically significant with orbital complications. The computed tomography scan images show pansinusitis only found in groups with orbital complication. Due to its posterior location, sphenoid sinusitis can spread directly to the posterior orbit and cause orbital apex syndrome without first going through the classic stages of orbital complications. Patients with deterioration of vision and worsening ophthalmoplegia are candidates for immediate spheno-ethmoidectomy and optic nerve decompression. This procedure can be combined with orbital decompression if the patient manifests increased intraocular pressure.[3]

Our study found that diabetes mellitus was not a significant risk factor for orbital complication. This is different with common studies. Patients with comorbid or underlying conditions, such as diabetes and chronic renal failure with impaired immune function may have higher risk for orbital complications.[5] Similar with orbital complications, systemic diseases are the risk factors for odontogenic sinusitis, such as diabetes mellitus and immunodeficiency. This is thought to be due to the inability of the immune system to resist infection or the difference in the type of pathogens involved in the infection. People with systemic diseases also have a higher risk of complications, higher mortality, and a longer hospital stay.[16]

Leukocytosis was recorded in 14 patients, in which 10 patients experienced orbital complication while 4 patients did not. The assessment of absolute neutrophil count showed a higher ANC count (>7000 cells/mL) in

13 patients. In current series, most patients presenting with orbital complications of acute rhinosinusitis have elevated leukocyte and ANC counts.[22] Experimental studies have demonstrated that neutrophil-mediated abscess formation is a relevant component of innate immune response which aids host defense against skin infections, inhibiting the spread of pathogens to deeper tissues.[22] Raised leucocyte count as well as left shift (an increase in the number of immature leucocytes in the peripheral blood, particularly neutrophil band cells) have been reported as strongly associated with (subperiosteal or intraorbital) abscess formation. In our study we found that higher absolute neutrophil count was associated with orbital complication in odontogenic rhinosinusitis.

The limitation of this study is we did not analyze other risk factors for orbital complications such as biofilm factor, immunocompromised and other chronic diseases. For further study, we recommend to analyze all of the risk factors.

CONCLUSION

Orbital complications in odontogenic sinusitis were associated with mucopurulent discharge, absolute neutrophil count and sinus involvement. A thorough history taking and clinical examination along with laboratory examination and radiological evaluation is mandatory in patients with suspected complications. Treatment requires multidisciplinary collaboration between otorhinolaryngologist, ophthalmologist and dental surgeon. Larger studies will be necessary to assess the correlation of complications of odontogenic rhinosinusitis.

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