Pediatric Preseptal and Orbital Cellulitis: Analysis of Clinical, Laboratory and Imaging Findings of 123 Cases.

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Research Article

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Abstract

Background: To compare the clinical and laboratory characteristics and imaging methods of patients diagnosed with preseptal cellulitis and orbital cellulitis in the pediatric age group.

Methods: The study was designed retrospectively and the medical records of all patients who were hospitalized with the diagnosis of preseptal cellulitis and orbital cellulitis were reviewed. The findings of preseptal cellulitis and orbital cellulitis groups were compared. The risk factors for the development of orbital involvement were analyzed.

Results: A total of 123 patients were included, 90.2% with preseptal cellulitis and 9.8% with cellulitis. The male gender ratio was 60.2% and the mean age was 72±43 months. While all patients had eyelid swelling and redness 20.3% had fever. Ocular involvement was 51.2% in the right eye and 4.9% in both eyes. The most common predisposing factor was rhinosinusitis (56.1%). Radiological imaging (Computed tomography/magnetic resonance imaging) was performed in 83.7% of the patients. Subperiostal abscess were detected in 7 cases (5.6%) which three of the cases were managed surgically and four were treated with medically. The levels of c-reactive protein were significantly higher in patients with orbital involvement (p:0.033) but there was no difference between the presence of fever, leukocyte and platelet values.

Conclusions: Rhinosinusitis was the most common predisposing factor in the development of preseptal cellulitis and orbital cellulitis. Orbital involvement was present in 9.8% of the patients. It was determined that high c-reactive protein value could be used to predict orbital involvement. Keywords: Childhood, preseptal cellulit, rhinosinusit, orbital cellulit, subperiostal abscess.

Background

Periorbital cellulitis is characterized as an infection of the soft tissue surrounding the eye [1]. Periorbital cellulitis can be subdivided into two major entities: the preseptal cellulitis or the postseptal cellulitis, the latter also known as orbital cellulitis. Both preseptal cellulitis and orbital cellulitis cause swelling and redness around the eye. It is critical to exclude orbital cellulitis, which requires prompt management to avoid serious complications [2]. In childhood period early diagnosis and treatment of orbital infections are important to prevent serious complications such as vision loss and spread of infection to intracranial structures and death [3–5].

Preseptal and orbital infections are distinct diseases, in which orbital septum is the dividing reference point [6, 7]. The differential diagnosis between these two conditions can be challenging, since the clinical manifestations with periorbital erythema and edema are similar. However, some clinical signs can help to differentiate both conditions: ocular pain and fever can be present in both, but are more frequent in orbital cellulitis; proptosis, diplopia, diminished visual acuity, abnormal pupillary reflex, ophthalmoplegia, chemosis and pain with eye movements are signs suggesting orbital involvement and predict postseptal involvement/orbital cellulitis [8].

Sinusitis is the most common predisposing factor for orbital cellulitis, but it is also an important cause of preseptal cellulitis [2, 7]. Nevertheless, there are other routes of infection such as extension of adjacent structures infections (eyelid and dental infections, conjunctivitis), direct inoculation with cutaneous or orbital trauma, ophthalmologic surgery, animal bite or cutaneous infection like impetigo or herpetic infection [7, 9].

There are many classification schemes for orbital cellulitis including the Chandler classification and the Maloney classification [10]. The Chandler classification is based on specific clinical findings, which today are used in conjunction with CT (computed tomography) to determine stage [11]. According to Chandler's classification, which was defined in 1970, it is divided into 5 groups according to infection location: group 1 Inflammatory edema (Preseptal cellulitis), group 2 orbital cellulitis, group 3 subperiostal abscess, group 4 orbital abscess and group 5 infection spreading backward and creates cavernous sinus thrombosis [12].

While multiple risk factors, criteria, and characteristics have been discussed in the literature, there are no established guidelines specific to the management of orbital cellulitis in the pediatric population [10]. Currently, there is no sufficient data on ideal radiological imaging model and time in diagnosis, steroid use in treatment, and surgical intervention time in the presence of abscess.

This study reports the experience at a central hospital in Istanbul Turkey during a 5-year period, characterizing and comparing preseptal and orbital cellulitis regarding epidemiology, clinical features, treatment, complications and clinical course. Our second aim in this study was to determine the risk factors in the development of orbital involvement.

Methods

Design, setting, and participants

The medical records of all patients who were hospitalized with the diagnosis of preseptal cellulitis and orbital cellulitis between January 2014 and December 2018 (5-year) were reviewed retrospectively. Demographic (age, gender, hospitalization) and clinical characteristics (ocular findings, presence of fever, duration of post-treatment fever, etiological causes, presence of orbital involvement), laboratory results (leukocyte count, platelet count, C-reactive protein level), radiological examination results CT and/or magnetic resonance imaging (MRI) and treatment information (duration of inpatient treatment, need for surgical treatment of antimicrobial type) were recorded.

All patients received ophthalmologic evaluation with visual acuity, pupil reactivity testing of the affected eye and ocular movement impairment. All patients evaluated by the ear-nose-throat (ENT) specialist for any sign of acute rhinosinusitis (edema of nasal mucosa and purulent secretions). A CT scan was performed in the presence of clinical signs of orbital involvement or not responding to medical therapy within 48 hours.

The patients were divided into two groups: preseptal cellulitis and orbital cellulitis for statistical analysis. Preseptal cellulitis and orbital cellulitis were clinically diagnosed by periorbital edema and/or erythema. Patients were diagnosed as orbital cellulitis if they had clinical signs (photophobia, proptosis, painful extraocular motion, ophthalmoplegia, visual impairment or chemosis) of orbital involvement or positive radiological imaging findings. In the absence of signs of orbital involvement, the diagnosis of preseptal cellulitis was considered. The properties of the two groups were compared. The factors affecting orbital involvement were examined.

The study was conducted in accordance with the Declaration of Helsinki. Bakirkoy Sadi Konuk Training and Research Hospital Ethics Committee approved the study Ethical committee number is 2016 – 158.

Statistical Analysis

SPSS 11.5 for Windows program was used for statistical analysis. Descriptive statistics were used in the evaluation of clinical features; The number and percentage for categorical variables, mean, standard deviation, minimum, maximum for numerical variables were given. Differences between preseptal cellulitis and orbital cellulitis were tested using an $\chi 2$ test or Fisher exact test for categorical variables and a Student's t-test or Mann Whitney test for independent samples, as appropriate. Statistical significance level was accepted as $p < 0.05$.

Results

During the study period, 123 patients were diagnosed as preseptal cellulitis and orbital cellulitis. Demographic characteristics of all patients are presented in Table 1. Their age varied from four month to fifteen years. Eyelid redness and swelling were present in all patients and fever was present in 20.3% (n: 25) of the patients. Right eye involvement was 51.2% (n:63), left eye involvement was 43.9% (n:54) and bilateral involvement was 4.9% (n:6). Preseptal cellulitis was diagnosed in 90.2% (n: 111) of the patients and orbital cellulitis in 9.8% (n: 12). The etiologic factors for the development of preseptal and orbital cellulitis in patients are presented in Table 1. The most common etiologic factor was sinusitis and diagnosed in 56.1% (n: 69) of the patients. This rate was 100% (n:12) in the orbital cellulitis group and 51.3% (n:57) in the preseptal cellulitis group. The most common ethmoid sinus (n:56, 81.1% of all rhinosinusitis cases) and maxillary sinus (n:56, 81.1%) were involved. The distribution of sinus involvement in patients with rhinosinusitis is shown in Table 2. Herpetic skin infection was the second most common etiology in preseptal cellulitis patients (12.6%, n:14).

Table 1
Demographic characteristics and clinical findings of all patients and risks factors for orbital cellulite.

		Total	Orbital Cellulite	Preseptal Cellulite	p
n (%)		123(100)	12(9.8)	111(90.2)	
Gender	Boy, n(%)	74(60.2)	7(58.3)	67(60.3)	0.562
	Girl, n(%)	49(39.8)	5(41.7)	44(39.6)	
Age (months)	mean ± SD	72 ± 43.7	85.6 ± 37.7	70.4 ± 44.2	0.198
	(lower-upper limit)	(4-180)	(48–152)	(4-180)	
Fever, ≥ 38 ^{0}C	n(%)	25 (20.3)	2 (16.7)	23 (20.7)	0.488
Etiological factors	Rhinosinusitis	69 (56.1)	12(100)	57(51.3)	**< 0.001**
n (%)	Herpetic skin	14(11.4)		14(12.6)	
	Conjunctivitis	7(5.7)		7(6.3)	
	Skin infection	6(4.9)		6(5.4)	
	Dental abscess	5(4.1)		5(4.5)	
	Trauma	3(2.4)		3(2.7)	
	Insect bite	3(2.4)		3(2.7)	
	Dacryoadenitis	1(0.8)		1(0.9)	
	Undefined	15(12.2)		15 (13.5)	
Laboratory findings					
Leukocytes /mm^3	mean ± SD	14001 ± 5253	16488 ± 5875	13732 ± 5139	0.716
	(lower-upper limit)	(4740-30 100)	(7090–23670)	(4740-30 100)	
Platelets/mm^3	mean ± SD	340536 ± 92353	353583 ± 73049	339126 ± 94369	0.735
	(lower-upper limit)	(141000–725000)	(171000–470000)	(141000–725000)	
CRP, mg/dl	mean ± SD	4.47 ± 5.43	8.26 ± 5.86	4.07 ± 5.25	**0.033**
	(lower-upper limit)	(0.2–27.3)	(1.08-20.0)	(0.20–27.3)	
Surgical treatment	n(%)	3 (2.4)	3(25)	0	**< 0.001**

		Total	Orbital Cellulite	Preseptal Cellulite	p
Length of hospitalization	days	7.1 ± 3.3	12.3 ± 5.7	6.6 ± 2.4	**0.006**

Table 2
Distribution of sinus involvement in patients with rhinosinusitis

Distribution of sinus involvement in rhinosinusitis (n:69) cases	**n (%)**
Ethmoid rhinosinusitis	56 (81.1)
Maxillary rhinosinusitis	56 (81.1)
Frontal rhinosinusitis	27 (39.1)
Sphenoid rhinosinusitis	27 (39.1)
There were multiple sinus involvement in many patients.	
Distribution of subgroup sinus involvement of patients	
Panrhinosinüzit	21(30.4)
Ethmoid + maxillary rhinosinusitis	19 (27.5)
Isolated maxillary rhinosinusitis	11 (15.9)
Isolated ethmoid rhinosinusitis	6(8.7)
Ethmoid + frontal rhinosinusitis	4(5.8)
Ethmoid + maxillary + sphenoid rhinosinusitis	4(5.8)
Isolated frontal rhinosinusitis	1(1.4)
Ethmoid + maxillary rhinosinusitis	1(1.4)
Maxillary + sphenoid rhinosinusitis	1(1.4)
Ethmoid + frontal + sphenoid rhinosinusitis	1(1.4)

When file record of imaging examinations performed to patients were evaluated; 63.4% (n:78) of the patients had CT and 16.3% (n:20) had MRI + CT and 4.1% (n:5) had only MRI. It was determined in 16.3% (n:20) patients that no imaging was performed because of the general condition of the patients was good and the lesion was small and regression was detected with treatment in a short time. All patients who underwent imaging had radiological findings of preseptal cellulitis. CT and MRI findings of the patients are given in Table 3.

Table 3
Distribution of CT and MR findings

CT findings (total 98 cases)	**n(%)**
Rhinosinusitis	57(46.3)
Preseptal cellulitis symptoms only	31(25.2)
Rhinosinusitis and orbital subperiostal abscess	5(4)
Rhinosinusitis, orbital soft tissue inflammation	2(1.6)
Maxillary rhinosinusitis + abscess	1(1.6)
Maxillary abscess	1(1.6)
Dacryoadenitis	1(1.6)
MRI findings (total 25 cases)	**n(%)**
Rhinosinusitis	7(6.5)
Preseptal cellulitis symptoms only	5(4.1)
Rhinosinusitis, inflammation of the medial rectus	3(2.4)
Rhinosinusitis, inflammation of the medial rectus, subperiostal abscess	3(2.4)
Rhinosinusitis and orbital subperiostal abscess	2(1.6)
Rhinosinusitis and dural contrast enhancement	2(1.6)
Rhinosinusitis, orbital soft tissue inflammation	1(0.8)
Maxillary abscess	1(0.8)
Dacryoadenitis	1(1.6)

The distribution of the first laboratory findings determined in the patients' admissions is presented in Table 1. All children received intravenous (i.v.) antibiotic treatment. The most common antibiotic types were ceftriaxone + clindamycin 40.7% (n: 50) and ampicillin + sulbactam 25.2% (n: 31) and teicoplanin + ceftriaxone 8.9% (n: 11) and ceftriaxone 8.1% (n: 10).

The distribution of 12 patients (9.8%) with orbital involvement was as follows: subperiostal abscess (n:7), inflammation of the medial rectus muscle (n:3) and inflammation of the orbital soft tissue (n:2). Surgical drainage was required in 3 (2.4%) of 7 patients with orbital subperiostal abscess since they did not regress with medical treatment after 48 hours. The age distribution of patients who underwent surgery was: median 66 months, first quarter 70 months and third quarter 120 months.

When the risk factors for orbital involvement were evaluated, there was no significant difference between the groups in regard to gender, presence of fever, leukocyte count and platelet count (p: 0.562, p: 0.488, p: 716 and p: 0.735, respectively). The mean age of patients with orbital involvement (85.6 ± 37.7 months) was higher than without orbital involvement patients (70.4 ± 44.2 months) but it was not statistically significant (p: 0.198). When C-reactive protein (CRP) levels were associated with orbital involvement; CRP value was found to be significantly superior in patients with orbital involvement (p: 0.033). The length of hospitalization was significantly longer in patients with orbital involvement (p: 0.006) (Table 1).

Meningitis (1.6%) was detected in two patients with rhinosinusitis and preseptal cellulitis. without orbital involvement. Dural contrast enhancement (dural thickening and contrast enhancement in the left frontal region in one patient, dural contrast involvement in the left cerebral hemisphere in one patient) detected on the MRI scan of these two patients. One of these patients had a paranasal sinus CT that was compatible with panrhinosinusitis before MRI. Lumbar puncture was performed to exclude or confirm the diagnosis of meningitis. Cerebrospinal fluid (CSF) glucose and protein levels were normal in both cases, but cell count was 64/mm3 and 81/mm3 leukocytes. Their treatment was continued as vancomycin + ceftriaxone for 14 days. There was no growth in CSF culture of both patients.

There were 6 patients with two eye involvement. The etiology of these patients were herpes in 2 patients, skin infection in 2 patients, trauma in one patient, and pansinusitis in one patient.

Discussion

Preseptal and orbital infections are distinct diseases, in which orbital septum is the dividing reference point [6]. Preseptal cellulitis is generally a mild condition but orbital cellulitis sometimes represents a serious complications such as visual loss [4, 5]. The differential diagnosis between these two conditions can be challenging, since the clinical manifestations such as induration or erythema with periorbital erythema and edema are similar. Clinical signs specifically suggesting post-septal involvement include proptosis, chemosis, ophthalmoplegia, or decreased visual acuity. However, periorbital edema can often limit physical exam and hinder ability to differentiate between the two [10]. Therefore, if orbital cellulitis is suspected or if bedside examination cannot rule it out, a sinus CT with contrast is warranted within 24 h of presentation [13].

While there is no gender difference in preseptal cellulitis, orbital cellulite has been reported to be more common in male also more common in winter because of its association with upper respiratory tract and paranasal infections [2]. In the series of Botting et al. consisting of 262 pediatric patients with periorbital infection, the frequency of preseptal cellulitis and orbital cellulitis were found 87% and 13% [5]. In studies performed in our country reported that the frequency of preseptal cellulitis is between 81% and 88.9%, the frequency of orbital cellulitis is between 11.9% and 19% in admitted children with periorbital infections [14, 15]. The similarly ratio of preseptal cellulitis and orbital cellulitis detected in our study. In studies comparing age distribution of preseptal cellulitis and orbital cellulitis cases, it was reported that the mean age of patients with orbital cellulitis was higher than those with preseptal cellulitis [6, 16, 17]. In the study

of Botting et al., [5] while the mean age distribution in preseptal cellulitis/orbital cellulitis cases was 3.9 years/7.5 years, it was found to be 4.7/8.1 years in Demir et al. [14]. Although the exact cause of advanced age cannot be explained, this may be attributed to the fact that rhinosinusitis is more common in the etiology of orbital cellulitis than preseptal cellulitis and that the aeration of the sinuses in the younger age group is not yet completed. The age of the patients with orbital involvement was larger than that of the patients without orbital involvement in our study, but this difference was not statistically significant. Male gender was found to be more frequent in patients with or without orbital involvement [5, 15]. While the male/female sex ratio was 1.4/1 in orbital involvement, it was 1.5/1 in our patients with preseptal cellulitis cases. There are also higher rates of male dominance reported by Nageswaran et al., that the mean age of 7.5 years and a male/female ratio of 2.7/1 in 41 patients under 18 years of age with orbital cellulitis [6].

The most common etiologic cause was sinusitis in the whole patient group. While sinusitis was detected in all orbital cellulitis group, it was found in approximately half of the preseptal cellulitis group. In the literature, it is reported that 75% of orbital infections are associated with sinusitis and most commonly with ethmoid sinusitis [15, 17–19]. However, there are also studies in which the incidence of sinusitis is lower in patients with preseptal cellulitis [5, 14]. Similarly to our results Nageswaran et al. reported that all patients with orbital cellulitis was associated with sinusitis [6].

CT is the most useful imaging method and the most widely accepted diagnosis in the diagnosis of sinusitis and in evaluating a patient with orbital infection, shows the presence of complications such as orbital abscess, subperiostal abscess [7, 20, 21]. Imaging should also be performed in patients who do not heal with intravenous antibiotic therapy and who cannot perform eye and visual examination effectively due to their age. CT has been found to be accurate for diagnosing orbital cellulitis and subperiosteal abscess, with reported accuracies ranging from 91 to 100% [22, 23]. It has been reported that imaging methods are used between 12% and 96% in preseptal and orbital cellulitis cases [5, 15–17]. Orbital cellulitis is reported to be most commonly associated with sinusitis especially ethmoid sinusitis [18, 19]. Botting et al. according to CT findings, ethmoid sinus involvement was 86% and maxillary sinus involvement was 60% in patients with postseptal cellulitis [5]. In the study of Nageswaran et al. 98% ethmoid rhinosinusitis was found [6]. Similar to our study, there are studies with high maxillary sinus involvement [17].

Intracranial complications are an important problem that should be evaluated in preseptal cellulitis and orbital cellulitis. In a review of 16 studies included 180 cases with intracranial complications due to sinusitis in childhood period, reported that the frequency of complications were subdural empyema (49%), epidural abscess (36%), cerebbral abscess (21%) and meningitis (10%) [24]. MRI is the preferred method for detecting intracranial complications with MRI venography when cavernous sinus thrombosis is considered [7, 15, 20, 21, 25, 26]. MRI is more sensitive in evaluating orbital and intracranial complications of sinusitis [25]. Although MRI recommended for cases in which there is either clinical or CT-based suspicion for intracranial complications. The dural contrast enhancement was detected by orbital MRI imaging in two patients in the preseptal cellulitis group and the diagnosis of meningitis in

these children showed the importance of MRI in our study. It supported the information that MRI is more suitable for detecting intracranial complications due to sinusitis. Also orbital MRI findings were detected in three patients who had previously diagnosed sinusitis with CT and did not recover with antibiotherapy in our study. One patient had inflammation of the medial rectus muscle and two patients had inflammation and subperiostal abscess in the medial rectus muscle. The radiological findings of these cases confirm that MRI is a more sensitive method for evaluating orbital complications of sinusitis [25].

The pediatric subperiosteal abscess is considered an abscess pocket localized between the lamina papyracea and the periorbita. Although same authors accept to drain the for subperiosteal abscess in children as soon as possible [1], several authors pointed out the effectiveness of antibiotic therapy in children less than 9 years of age [10, 27]. In general, surgical treatment is mainly dependent on the presence of visual impairment, ophthalmoplegia and proptosis. The need for surgical treatment in subperiosteal abscess has been reported in 14–23% in various studies [5, 14, 17]. In our study, 3 patients with orbital subperiostal abscess (2.4% in the whole patient group and 25% in the orbital cellulitis group) underwent endoscopic drainage due to the need for surgical treatment and 4 patient successfully treated with systemic antibiotics alone. Recurrence of infection occured rarely in same cases [2, 28]. It is suggested that patients with chronic or recurrent infections and complications should undergo further investigation of their immunological status (e.g. IgG deficiency) [28].

In recently published studies, Nation et al. found that 43% (11 of 26) pediatric patients with abscesses ≥ 500 mm3 were still able to be managed medically [29]. Le et al. reported that patients with larger subperiosteal abscess could be successfully treated with systemic antibiotics alone, choosing the abscess cut-off size of 3.8 mL. Specifically, if the subperiosteal abscess volume is < 3.8 mL, then the probability of surgery is 12%; if the subperiosteal abscess volume is > 3.8 mL, then the probability of surgery is 71% [30]. Currently accepted that orbital cellulitis, particularly subperiosteal abscesses, in children is not an absolute indication for immediate surgical intervention. Conservative nonsurgical measures including close monitoring with antibiotics can be safe and effective if appropriately used, depending on patient characteristics, exam findings, clinical course, and imaging [10].

In some studies, it has been reported that fever at admission, high leukocyte count and C-reactive protein were associated with orbital involvement [2, 5, 31, 32]. Demir et al. compared to mean CRP value in orbital cellulitis group and the preseptal cellulitis group (CRP value 37.5 mg/L vs 13.5 mg/L, respectively) and were found to be significantly higher in orbital cellulitis group [14]. However, Kocabas et al. found no statistically significant difference in terms of mean CRP levels in patients with orbital and preseptal cellulitis [17]. In our study, it was found that the CRP value was significantly higher in orbital involvement on the other hand there was no relationship between orbital involvement and fever and leukocyte values.

Conclusions

Consequently, the most common etiologic factor in the development of preseptal cellulitis also in the orbital cellulitis was found sinusitis and the incidence of orbital involvement was 9.8% in our study. It was

seen that high CRP value can be used to predict orbital involvement in children with periorbital infection. MRI is a more sensitive imaging method in orbital involment with intracranial and orbital complications. Medical treatment should be tried first in cases with subperiosteal abscess, if do not respond to medical treatment in patient, surgical treatment should be planned.

Abbreviations

CRP: C-reactive protein

CT: Computed tomography

CSF: Cerebrospinal fluid

ENT: Ear-nose-throat

MRI: Magnetic resonance imaging

Declarations

Ethics approval and consent to participate:

The trial was conducted in accordance with the Declaration of Helsinki (as revised in 2013). This study was reviewed and approved by by the Bakirkoy Sadi Konuk Training and Research Hospital Ethics Committee (158/2016).

Consent for publication:

Not applicable

Availability of data and materials:

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests:

The authors declare that they have no competing interests.

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Authors' contributions:

LB and NOS have made substantial contributions to the conception and design of the work. GKE, ZMY, NH, SH, FBP and UY contributed to the acquisition, analysis and interpretation of data. AB and LB wrote the manuscript. LB and GKE contributed to the revision of the final version of the manuscript and supervised the project. All listed Authors have approved the submitted version of the manuscript.

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