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Early Complications of Acute Rhinosinusitis in Pediatric Practice

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Abstract: The acute form of rhinosinusitis is a common source of periorbital infection in young infants. We investigated the pediatric patients in an effort to identify the traits that are common among those who go on to develop subperiosteal orbital abscesses and require urgent surgery for acute orbital edema.

Methods: We reviewed 64 children younger than 18 years old in an observational retrospective cohort study. Radiography was used to make the diagnosis of periorbital abscess, and computed tomography was used to demonstrate that all of the patients also had sinusitis concurrently.

The patients had a mean age of 6.95 years, and 42 of them, or 65.63 percent, were male (the male-to-female ratio was 1.91). Thirty patients (46.88%) had surgical drainage, whereas the other thirty-four patients (53.13%), simply got antibiotic treatment. According to the results of a bivariate analysis, the variables that were linked with the development of an abscess were as follows: an age of 6 years or less ($p = 0.023$), proptosis ($p = 0.012$), fever (p 0.001), and a white blood cell count of more than 11,100 ($p = 0.004$). According to the findings of a multivariate study, fever and proptosis were two independent predictors that predicted the development of an abscess. Staphylococcus aureus, Streptococcus viridaus, and coagulase-negative staphylococci were the microorganisms that were cultured the most commonly in patients who had surgical drainage, and 29% of our patients had polymicrobial pus cultures.

Abscess development is the most significant determinant in determining whether or not an antibiotic therapy for periorbital infections associated to sinusitis will be successful in curing the infection. Patients who are experiencing fever in addition to proptosis have an increased risk of developing subperiosteal orbital abscesses.

Key words: Orbital cellulitis, pediatrics, sinusitis, and subperiosteal abscess.

Introduction

Subperiosteal orbital abscesses (SPOAs) have always been considered as acute surgical emergencies because of consequent eyelid and periorbital skin cellulitis in children [1]. SPOAs and orbital cellulitis in children are infectious processes in which the abscess pocket is considered to be located between the periorbita and the lamina papyracea. Infection is thought to most commonly come from maxillary sinusitis, although some argue that vascular spread through adjacent cranial, orbital and facial structures are also possible [2-4].

Because of the complications, SPOA requires timely and effective treatment [3]. The most common complications include loss of vision, endophthalmitis, intracranial spread (e.g. meningitis, brain abscess, cerebritis), cavernous thrombosis and death [5,7].

The diagnosis of SPOA is typically made on the basis of clinical examination and radiographic data. Once the diagnosis is confirmed, the method of treatment can be a controversial issue. One of these is whether paediatric SPOAs should be treated with medication or surgery [4,8]. Another issue is the selection of the type of surgical approach. Among the surgical options are the external Lynch incision, transcapsular or transconjunctival incision. [9,4,1]

The aim of this study was to analyse clinical factors that predict the development of SPOAs and to identify the characteristics of patients who have a poor response to antibiotic treatment and require a surgical treatment. The microbes identified postoperatively are discussed and could provide clinicians with guidance on the selection of appropriate antibiotics.

Materials and methods

The collection of information

The Institutional Ethical Review Board of Samarkand State Medical University gave its clearance to proceed with this research project. A retrospective examination of the medical records of individuals less than 18 years old who were seen at the ENT department of SamSMU for treatment of orbital infections between the years 2005 and 2020 was carried out by our team. All of the patients originally presented themselves to the pediatric emergency room complaining of orbital pain and discomfort. In order to confirm the diagnosis of orbital infection and associated sinusitis, a computed tomography scan of the paranasal sinuses or the orbit was done on each patient. On a CT scan, we looked for signs of fluid density or annular enhancement, which indicated liquefaction of an existing cellulitis. This was how we characterized subperiosteal abscess. We did not include patients who had orbital cellulitis as a result of surgery or trauma. Additionally, we did not include patients who had structural abnormalities of the eye, immunosuppressive diseases, or cancers.

Patients who presented at the hospital with impaired vision, signs of cavernous sinus or cerebral lesions were immediately given surgical drainage as an emergency treatment. Other patients received antibiotics as the first line of treatment when they were treated. In patients who were first treated with medicine, surgery was only recommended in the event that the treatment failed to alleviate the symptoms (such as persistent fever or persistent periorbital edema), the symptoms worsened, or problems developed (such as changes in vision, cavernous sinus thrombosis, or cerebral lesions). The method of surgical removal of the SPOA was decided upon after determining its precise position. When the SPOA damaged the medial aspect of the orbit, surgery was conducted through the nasal passages utilizing an endoscopic transnasal technique. If the SPOA was located in the preseptal region and it was unable to be properly drained endoscopically, an external approach was selected as the treatment method. In cases where the supralateral abscess was found to have significantly grown, the combination treatment was utilized.

We went through each case and went over their presenting symptoms as well as their clinical progress. The medical records were particularly evaluated for the patient's age when they presented, the length of time they had periorbital edema, their white blood cell (WBC) count, their level of C-reactive protein (CRP), and their body temperature when they first presented. Among the clinical signs that were documented was a high temperature, proptosis, chemosis, diplopia, and vision loss. It was determined through reviewing the CT images where the SPOA and sinusitis were located. SPOAs that were medially, superiorly, or laterally based were some of the possible descriptions. A notation was made on the method of surgical approach. Any undesirable outcomes or problems resulting from surgical operations were meticulously recorded.

Clinical data collection

The characteristics of the illness, as well as its course in each patient's clinical presentation, were investigated. We went through the patient's medical records and looked at their age when they were admitted, how long they had had periorbital oedema, their white blood cell count (WBC), their level of C-reactive protein (CRP), and their body temperature when they were admitted. Fever, proptosis, chemosis, diplopia, and visual impairment were some of the clinical signs that were seen. The CT images were analyzed to determine the precise site of the SPOA and sinusitis. Possible descriptions were medial, superior and lateral SPOA. There was a recording of a sort of surgical method. Documentation was also done for any adverse events or problems that arose as a result of any surgical procedures.

Statistical research methods

The R-studio statistical tool, version 3.6.2, was utilized throughout the process of doing statistical analysis. The x2 test was utilized in order to investigate the possible links between clinical variables and the development of abscesses. Classification tree analysis and regression R studio data management software were used to establish a cut-off value for the white blood cell count. Binary logistic regression was utilized in order to investigate the elements that were predictive in multivariate analysis. In this study, statistical significance was determined to exist when the p value was lower than 0.05.

Results

The characteristics of 78 patients with orbital cellulitis are presented in Table 1. The ages of the children ranged from 0.8 to 18 years, with a mean age of 8.25 years. The disease occurred most frequently between the ages of 4 and 8 years. Forty-four patients (56.4%) were male (male-to-female ratio of 2.0 to 1; Table 1). Sixty-two (79.5%) had fever at or after presentation. Proptosis was present in 34 (43.6%), chemosis in 26 (33.3%), affected vision in 11 (14.1%), and diplopia in 29 (37.2%). Subperiosteal or other orbital abscesses were present in 45 (57.7%).

Table 1. Demographic characteristics	Units	Total N=78 patients
Age (years)	Mean±SD	8.25±5.93
Age range (years)	Min-Max	0.8 to 18
Pathology side		
Bilateral	n(%)	6(7.7%)
Right side	n(%)	31 (39.7%)
Left side	n(%)	41 (52.6%)
Sex		
Male	n(%)	44 (56.4%)
Female	n(%)	22 (43.6%)
Category of pathology		
Subperiosteal abscess	n(%)	49 (62.8%)
Subperiosteal cellulitis	n(%)	29 (37.2%)
Surgical treatment		
Not performed	n(%)	37 (48.4%)
Performed	n(%)	41 (52.6%)
Type of surgical treatment		
Endoscopic surgery	n(%)	21 (51.2%)
External surgery	n(%)	20 (48.7%)

Sinuses infected on each side of each patient were counted on CT scans. Similarly, in descending order of frequency, the infected sinuses were maxillary, ethmoid, frontal and sphenoid sinuses. Two patients (2.6%) with intracranial complications were identified: 1 with an epidural abscess and 1 with a frontal lobe abscess. A total of 41 patients (52.6%) underwent surgery. Twenty-one (51.2%) patients were immediately referred for surgery due to clinical signs of decreased visual acuity and limited eye movements or the presence of intracranial complications. The remaining twenty patients (48.7%) underwent surgery an average of 5.87 days after antibiotic treatment. Of the 41 patients who underwent surgery, 21 patients (51.2%) had a transnasal endoscopic approach, 20 (48.7%) had an external approach. All patients recovered after treatment. No patients experienced long-term surgical complications, residual deficit or intracranial complications.

The cutoff value for an elevated WBC count was selected as 9.2 cells per liter by the classification and regression tree analysis.12 The sensitivities and specificities of different cutoff values are compared in Table 2.

Table 2. Sensitivity, specificity and according to different wbc count cutoff values

WBC Cutoff Values	Sensitivity	Specificity
9,2	94.4%	22.2%
10	91.7%	37.0%
11	88.9%	48.1%
12.5	66.7%	55.6%
15	36.1%	77.8%
18	13.9%	81.5%

Clinical characteristics were compared between younger children (7 years of age or less) and older children (more than 7 years of age; Table 3). The younger children had a higher frequency of proptosis and fever than did the older children (p = 0.046 and p = 0.003, respectively). The WBC count was higher among younger children (p = 0.051). The CRP level in younger children was higher than that in older children, but the difference was not statistically significant (p = 0.232). The frequency of diplopia was higher in older children than in younger children (p = 0.011). The percentages of patients who required surgery were similar in the two age groups. The hospitalization durations for the older and younger children were 9.16 and 13.17 days Citest, p = 0.105), respectively.

Thirty patients failed to respond to antibiotic treatment and required surgical drainage. We analyzed the relationship between surgery and clinical parameters including gender, proptosis, ophthalmoplegia, chemosis, fever, diplopia, WBC count (more or less than 11,100 cells per microliter), vision, age (6 yearsor less versus more than 6 years), and abscess formation. The only significant factor that predicted the necessity to perform surgery was the formation of abscess (Fisher's exact test, p = 0.012; odds ratio, 3.929; 95% confidence interval [CI], 1.363 to 11.327). We further analyzed clinical factors that affected the formation of abscess by x2 analysis (Table 4). Age of 6 years or less, proptosis, WBC count, and fever were significant factors. The odds ratios of these factors were fever, 14.143 (95% CI, 1.940 to 103.117); elevated WBC count, 4.179 (95% CI, 1.528 to 11.426); younger age, 1.987 (95% CI, 1.117 to 3.533); and proptosis, 1.837 (95% CI, 1.146 to 2.944). The hospital stays for the surgical and medication groups were 14.70 and 8.88 days (/-test, p = 0.007), respectively. On binary logistic regression analysis, fever (odds ratio, 19.77; 95% CI, 2.27 to 172.10) and proptosis (odds ratio, 3.34; 95% CI, 1.03 to 10.79) were independent factors that were associated with abscess formation (Table 5).

Table 3. Relationship between age and clinical parameters in periorbital infection in children

	Age <6 y		Age >6 y		p (Fisher's Exact Test)
	No.	%	No.	%	
Sex					0.597
Female	11	50.00	11	50.00	
Male	25	59.52	17	40.48	
Diplopia					0.011*
Yes	9	36.00	16	64.00	

No	27	69.23	12	30.77	
Vision					0.282
Yes	3	37.50	5	62.50	
No	33	58.93	23	41.07	
Proptosis					0.046*
Yes	21	70.00	9	30.00	
No	15	44.12	19	55.88	
Chemosis					0.211
Yes	19	65.52	10	34.48	
No	17	48.57	18	51.43	
Purulent rhinorrhea					0.130
Yes	11	44.00	14	56.00	
No	25	64.10	14	35.90	
Fever					0.003*
Yes	34	65.38	18	34.62	
No	2	16.67	10	83.33	
Surgery					0.321
Yes	19	63.33	11	36.67	
No	17	50.00	17	50.00	
WBCs (cells/pL)					0.051*
>11,100	30	63.83	17	36.17	
<11,100	6	35.29	11	64.71	
C-reactive protein	76.69	± 12.65	59.30	± 11.11	0.232
(mg/L)	(11 :	= 34)	(n =	= 18)	

Thirty children who had surgical procedures had cultures performed of an abscess (orbital or subperiosteal) and/or sinus. Most of the children received oral or parenteral antibiotics before the bacterial cultures. The most frequently used antibiotic regimen in our patients for initial parenteral therapy was amoxicillin-clavulanate potassium (31.25%), followed by cefuroxime sodium plus gentamicin sulfate (10.94%) and oxacillin sodium plus gentamicin sulfate (10.94%). Twenty-eight children had positive culture results, giving a positive culture rate of 93.33%. Twenty patients had 1 microbe, 3 had 2 microbes, 3 had 3 microbes, 1 had 4 microbes, and 1 had 5 microbes (Table 6).

Three children had positive blood cultures: 2 for oxacillin-resistant staphylococci and the other for coagulase-negative staphylococci. Overall, 8 of the 28 children (29%) had evidence of polymicrobial infection. The most frequently cultured bacteria were Staphylococcus aureus, Streptococcus viridans, and coagulase-negative staphylococci.

Table 5. Multivariate logistic regression analysis of parameters affecting formation of abscess by forward selection method

	Odds Ratio	95% Confidence Interval	P
Fever vs no fever	19.765	2.270 to 172.10	0.007*
Proptosis vs no proptosis	3.335	1.031 to 10.79	0.044*

*p < 0.05.

Table 4. Relationship between orbital cellulitis, subperiosteal abscess, and clinical parameters

	Orbital	Subperiosteal	p (Fisher's

	Cellulitis		Abscess		Exact Test)
	No.	%	No.	%	
Sex					1.000
Female	10	45.45	12	54.55	
Male	18	42.86	24	57.14	
Age					0.023*
<6 y	11	30.56	25	69.44	
>6 y	17	60.71	11	39.29	
Diplopia					0.439
Yes	9	36.00	16	64.00	
No	19	48.72	20	51.28	
Vision					1.000
Yes	3	37.50	5	62.50	
No	25	44.64	31	55.36	
Proptosis					0.012*
Yes	8	26.67	99	73.33	
No	20	58.82	14	41.18	
Chemosis					0.079
Yes	9	31.03	20	68.97	
No	19	54.29	16	45.71	
Purulent rhinorrhé a					0.615
Yes	12	48.00	13	52.00	
No	16	41.03	23	58.97	
Fever					<0.001*
Yes	17	32.69	35	67.31	
No	11	91.67	1	8.33	
WBCs (cells/pL) >11,100	15	31.91	32	68.09	0.004*
<11,100	13	76.47	4	23.53	

*p < 0.05.

Discussion

Treatment for a periorbital infection must begin as soon as possible and be highly successful, particularly for young patients. In most cases, intravenous antibiotic treatment is sufficient to treat orbital cellulitis associated with subperiosteal or retrobulbar abscess, and surgical drainage is not necessary.13 It is crucial and of practical utility to clinicians to have clinical markers that can predict the establishment of an abscess or the necessity of surgical intervention.

In children, the lamina papyracea, the bony barrier that separates the ethmoid sinus and the orbit, is rather thin. As a result, children are susceptible to the continuous spread of infection. There was reported to be a bimodal age distribution of orbital cellulitis, and between the ages of 4 and 7 years old, there were very few instances detected.13 According to the findings of our research, the incidence reached its highest point between the ages of 3 and 5 years. A male prevalence of orbital cellulitis was detected in our study (male-to-female ratio of 1.9 to 1), and it enhances the notion that a gender-related tendency is present in this particular illness. This ratio was calculated using male-to-female ratios [13].

Orbital CT scans with contrast infusion are the method of choice for providing the most reliable confirmation of a cellulitis or abscess diagnosis in the orbit [1-7]. However, in order to determine the severity of the condition, professionals often need to base their assessment on clinical symptoms and indicators. Patients, particularly young children, might avoid excessive radiation exposure if it were possible to identify the distinctive signs of orbital abscess and organize relevant exams at the appropriate time to make a connected diagnosis. Although there are a number of clinical indications of orbital cellulitis that have been reported to be unique (proptosis, ophthalmoplegia),1 it can be difficult to differentiate between periorbital (preseptal) and orbital instances of cellulitis in young children based only on clinical observations. This is especially true of cases with cellulitis in the eye. It has been noted that the clinical presentations of orbital cellulitis in patients who were more than seven years old and patients who were seven years old or less presented in a distinct manner in terms of the indicators of proptosis and ophthalmoplegia [6-12]. It has been noted that individuals with medial abscesses are likely to experience symptoms of unilateral periorbital edema and erythema, proptosis, chemosis, conjunctival injection, impaired ocular mobility, fever, or discomfort. This information can be used to differentiate cellulitis from abscess.18 According to the findings of our research, patients who had SPOAs were more likely to have proptosis, fever, and more visible leukocytosis than those who had cellulitis.

According to the research that has been done on SPOAs, the age of the patient is a crucial role, and different treatment regimens are necessary for younger children compared to older children [17-21]. According to Hanis, SPOAs in young infants often host single-aerobe infections (either Staphylococcus or Streptococcus). The SPOAs of patients older than 9 years old are characterized by a nature that is progressively polymicrobial and anaerobic [19]. It has been discovered that the infections that affect older children appear and progress in a clinical setting in a more complex manner.18 There was no significant difference in the rates of orbital cellulitis, SPOAs, or orbital abscess between the younger and older age groups, according to a study that was carried out by Nageswaran and colleagues. According to our research, we found that younger children were more likely to have symptoms such as proptosis, fever, and leukocytosis, whereas older children were more likely to experience diplopia (Table 3). In terms of the therapeutic response, isolated medial SPOAs that are caused by sinusitis in young children, particularly those who are under the age of 6 years old, are extremely receptive to treatment with intravenous antibiotics [13-18]. According to the findings of our research, kids younger than 6 years were at a greater risk of having SPOAs, and physicians should exercise increased caution when treating patients of this age for the possibility of consequences.

When deciding which medicines to employ, the microbiological information obtained from ocular abscesses or sinuses that are implicated is particularly relevant. Peptostreptococcus, Bacteroides species, and Fusobacteriuui necrophorum were the most common anaerobic microorganisms found in culture, whereas a-he-molytic or nonhemolytic streptococci, group A fl-hemolytic streptococci, and 5 aureus were the most common aerobic microbes found in culture. These microbes were found in the research that was published [11-15]. In that investigation, staphylococci with a lack of the coagulase enzyme were judged to be contaminants. A review of research conducted in Taiwan between the years 1994 and 1998 found that 10 of the abscess cultures were positive. The five-aureus staphylococcus epidermidis and three distinct types of gram-negative coliform bacteria were the most prevalent pathogens.-0 According to our investigation, the infectious agents were comparable to those identified in the study by Chang et al. Over the course of the past ten years in Taiwan, the infectious agents that are responsible for SPOAs have remained unchanged.

According to the research, the antibiotic combination ampicillin-sulbactam was the most common choice for first parenteral treatment (41%). This was followed by the combination of nafcillin and a third-generation cephalosporin (27%), which was most often ceftizoxime. The combination of amoxicillin and clavulanate was the oral antibiotic that was prescribed the most frequently (68%).13

In our patient population, polymicrobial pus cultures were seen in 29% of cases. Antibiotic treatment based on empirical evidence should protect against microorganisms associated with acute sinusitis as well as anaerobes. Because staphylococcus aureus was the most typically cultivated bacteria in our investigation, oxacillin and/or gentamicin were also taken into consideration for the coverage of this bacterium. If the pus culture shows oxacillin resistance, vancomycin hydrochloride or teicoplanin may be recommended as an alternative treatment [8-10].

The utilization of objective data, such as the measurement of intraocular pressure, was at one point suggested as a component of the medical care of SPOAs [13-15]. However, it can be challenging to get young children to participate while an ophthalmologic intraocular pressure test is being performed. In the course of our research, we analyzed the clinical parameters that may be determined by means of a physical examination as well as several laboratory tests in order to forecast the emergence of SPOAs. According to our research, individuals who had fever were at the greatest risk of not improving after receiving antibiotic therapy, necessitating the need for surgical drainage.

Conclusions

Because it helps physicians pick appropriate therapies, including whether to use antibiotics alone or conduct surgery, associated orbital edema is significant when trying to uncover characteristics that predict the failure of antibiotic treatment in acute rhinosinusitis. This includes deciding whether antibiotics alone should be used or whether surgery should be performed. Abscess development is the single most critical determinant in determining whether or not antibiotic therapy will be successful. Patients who had fever and proptosis were shown to have a greater likelihood of developing SPOAs in the multivariate analysis. The bacteria S aureus, S viridans, and coagulase-negative staphylococci were cultured the most commonly, and 29% of our patients had polymicrobial pus cultures. Antibiotics prescribed as a first line of treatment for orbital infections in children should be effective against these microorganisms.

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