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Орбитальные осложнения острого риносинусита у педиатрических пациентов: наблюдательное исследование

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Цель исследования. Описание опыта орбитальных осложнений острого риносинусита в педиатрической популяции и выявление факторов риска, связанных с тяжестью заболевания. Материал и методы. В данном ретроспективном анализе оценивались клинические исходы 78 детей, госпитализированных по поводу орбитальных осложнений в период с 2005 по 2020 год. Для изучения демографических данных и клинических симптомов использовалась описательная статистика. Результаты. Хотя до госпитализации все дети получали антибиотики, более чем у половины из этой когорты наблюдались постсептальные орбитальные осложнения. Была обнаружена значительная связь между возрастом при поступлении и тяжестью заболевания. Дети старше семи лет имели более тяжелые орбитальные осложнения и чаще нуждались в хирургическом вмешательстве, несмотря на назначение антибиотиков до госпитализации ($p < 0{,}001$). Выводы. В данном исследовании орбитальные осложнения II и III стадии при поступлении и старший возраст были наиболее важными факторами, определяющими неудачу медикаментозного лечения. Раннее обращение к отоларингологу должно быть рассмотрено для детей старше семи лет с ОРС, так как более серьезные орбитальные осложнения могут развиться, несмотря на антибиотики в доклинической стадии.
Ключевые слова: риносинусит, орбита, осложнения, возраст, тяжесть.

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The orbital complications of acute rhinosinusitis in pediatric patients: observational study

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Objectives. To describe the experience of orbital complications of ARS in the paediatric population and to identify risk factors associated with disease severity. Methods: This retrospective analysis evaluated the clinical outcomes of 78 children hospitalised for orbital complications between 2005 and 2020. Descriptive statistics were used to examine demographic data and clinical symptoms. Results. Although all children were treated with antibiotics prior to hospitalisation, more than half of this cohort experienced post-septal orbital complications. A significant association was found between age at admission and severity of illness. Children over seven years of age had more severe orbital complications and were more likely to require surgery despite the administration of antibiotics prior to hospitalisation ($p < 0.001$). Conclusions. In this study, stage II and III orbital complications at admission and older age were the most important determinants of failure of medical treatment. Early referral to an otolaryngologist should be considered for children older than seven years with ORS, as more severe orbital complications may occur despite preclinical antibiotics.
Keywords: rhinosinusitis, orbital, complications, age, severity.

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Acute rhinosinusitis (ARS) is a common paediatric disease manifested by inflammation of the nose and sinuses and usually follows a viral infection or allergic rhinitis and may be exacerbated by bacterial infection [1, 2]. ARS is a rare condition that carries a risk of severe complications and even death [1, 3]. The orbital complication of ARS is common among the naive paediatric population [3, 4]. It usually results in

the direct spread of infection, local thrombophlebitis and acute ethmoidal sinusitis, which is exacerbated in children due to immature immune systems and developmental anatomy [5].

Chandler et al. defined the orbital septum as an anatomical landmark that establishes the boundaries between the pre-and post-septal space and distinguishes the first two stages of orbital inflammation. The spread of infection into the post septal space carries a significant risk of complications such as irreversible vision loss, brain abscess and cavernous thrombosis, as well as negative consequences, i.e. prolonged hospitalisation and antibiotic therapy, and the need for surgery [5,6]. Chandler divided orbital complications into five stages according to the severity of the disease, which is still used today to determine response to treatment and prognosis.

Diagnosing post-septal orbital complications is often difficult on clinical examination, but early recognition and appropriate treatment is the only means of achieving a successful outcome in the paediatric population [7–9]. The treatment of ARS in children remains a controversial and emerging topic [10, 11]. There is considerable variation in the published literature regarding risk groups for severe orbital complications, the need for imaging studies, and indications for surgical intervention [12]. Therefore, we aimed to describe the experience with orbital complications of ARS in a paediatric population and to identify risk factors associated with disease severity.

Materials and methods

Study design and population

A retrospective cross-sectional study was conducted between 1st January 2005 and 31st December 2020. All children hospitalised with orbital complications of ARS at the regional multidisciplinary children medical centre were included in the study during this period. The diagnosis of ARS was made on the basis of the criteria of the European Position Sheet on Rhinosinusitis and Nasal Polyps (EPOS 2012). The orbital complications were classified according to the Chandler classification: I-I stage: inflammatory oedema and preseptal cellulitis, II stage: orbital cellulitis, III stage: subperiosteal abscess, IV stage: orbital abscess and V stage: sinus cavernosus thrombosis. In patients with post septal orbital complications (stage 2 or higher), the final classification was made after the CT scan.

Data collection

Patient demographics, length of hospital stay, prior antimicrobial therapy and clinical data, including presenting symptoms, physical examination, radiological findings and details of medication and surgical treatment, were obtained from medical records. Patient samples submitted for microbiological examination were identified, and detailed microbiological data were obtained from the database.

Clinical and radiological examination

All patients were examined by an otolaryngologist on admission to confirm the diagnosis of ARS. Sinonasal secretion characteristics were assessed visually, and pus samples were taken from all patients for culturing. Thereafter, all patients underwent ophthalmological and neurological examination for clinical identification of orbital complications. Those patients who were found to be abnormal on either of the two examinations underwent additional computed tomography (CT) scanning. A CT scan was also performed in patients whose ophthalmological examination was inconclusive and in patients who did not respond to treatment with medication.

Sampling and microbiology

Sinonasal aspiration was performed as a standard procedure in all patients before starting antibiotic therapy. Sinonasal aspiration is an endoscopic collection of samples from the middle nasal meatus using a technique that has shown to be accurate in the identification of the predominant bacterial pathogens with a 90% correlation with cultures. Anal puncture is a painful procedure and is not recommended in children except in special cases. Patients who underwent surgery also had excretions collected from the sinuses, and a pus sample from a drained abscess was sent for microbiological examination. Using microbiological methods, we identified gram stain, aerobic and anaerobic cultures and antibiotic susceptibility of cultures.

Surgical treatment

Surgical intervention was required for patients who had visual impairment at the time of admission and those who failed medical treatment. Treatment failure was defined as fever despite 48 hours of antibiotic treatment, progressive symptoms and worsening of inflammatory markers.

Endoscopic sinus surgery (ESS) aimed to expose the lamina papyracea (ethmoid labyrinth) to identify possible dehiscence and evacuate pathological tissue. In some cases, it was necessary to break through or partially remove part of the lamina papyracea as the result of extensive dehiscence.

Ethical review

The ethical Review Board of Samarkand State Medical University approved this study.

Statistical analysis

Descriptive statistics were performed to examine demographic data and clinical manifestations.

Categorical variables were presented as frequencies and their corresponding percentages. We presented continuous data as absolute numbers and percentages (%). Groups were compared using the Mann–Whitney test for continuous variables and the chi-square test for categorical variables. To evaluate the role of pre-hospital antimicrobial treatment in preventing orbital complications, we compared the use of pre-hospital antibiotic therapy with the stage of orbital complications and clinical outcomes. Clinical presentation and treatment outcome were also compared between younger (<7 years) and older children (>7 years). All analyses were performed using R-studio version 3.6.2.

Results

Baseline characteristics of the study population

Seventy-eight children hospitalised for orbital complications after ARS were included in the study. Forty-four patients were male (56.4%), with a sex ratio of 1.29:1. The mean age was 7.45 years (8 months – 18 years) and 48.7% were younger than seven years. A total of 70 (89.7%) had fever and 4 (5.1%) patients had visual disturbances. The majority of the patients (54; 69.2%) had orbital complications of Chandler grade I or II at the time of admission. Seventeen patients (21.8 %) had SPOA (grade III), and seven patients (8.9 %) had an orbital abscess (grade IV). None of the patients developed cavernous sinus thrombosis (grade V). Computed tomography of the paranasal sinuses was performed in 62 (85.9%) patients. Of the patients who underwent computed tomography, all 62 (100%) had ethmoid sinus, and 46 (88%) had maxillary sinus. The demographic and clinical characteristics are spresented in Table 1.

Treatment (medication and surgery)

Due to visual disturbances and restricted eye movement, four patients (5.1%) required immediate surgical intervention. The remaining 74 patients (94.9%) were initially treated with antibiotic medication, and 41 patients (52.6%) who did not respond to medication were indicated for additional surgical treatment. The most common treatment combination used in 90% of cases in this group was

Table 1

Sociodemographic and clinical characteristics

Таблица 1

Социально-демографические и клинические характеристики

Variable	N (%) (Total =78)
Age (years)	7.45 (8 months – 18 years)
Sex	
Female	37 (43.6%)
Male	41 (56.4%)
High fever	71 (91.0%)
Visual impairments	4 (5.1%)
Chandler stage	
I	29 (37.2)
II	25 (32.0)
III	17(21.8%)
IV	7(8.9%)
V	NA
Sinus involvement (based on CT imaging)	(n=62)
Ethmoid	62(100%)
Maxillary	46 (74.2%)
Frontal	12 (19.4%)
Sphenoid	4 (6.4%)
Pre-admission antibiotics	74 (94.9%)
Failure of medical treatment	41(52.6%)
Surgical treatment	41 (52.6%)
Average hospital stay (days) after antibiotic therapy	8.2 (4-17)
Average hospital stay (days) after surgery	12.4 (7-21)

a third-generation cephalosporin and metronidazole. The majority of patients who did not respond to medical treatment required surgery, 41 (52.6%), all had stage II or III orbital complications, while the majority of patients who responded to medical treatment, 30 (38.5%), had stage I or II orbital complications. A total of 46 patients underwent ESS, of which 93.5% were adequately treated with surgical drainage and three patients required additional ophthalmic surgery. All patients recovered well after treatment without any long-term complications.

Microbiology analysis

In total, 103 samples were obtained; 78 sinonasal secretion samples from all patients and 46 tissue samples from those who underwent EES. The results are shown in Figure.

Positive bacterial growth was detected in 86.4% (89/103) of samples: 67.9% (53/78) in sinonasal secretion samples and 94% (36/46) of tissue samples. Overall, 86 patients had one isolate, six patients had two isolates, and two patients had four isolates. In eight patients, several isolates were found in the sinonasal secretion. The most frequently cultured bacteria were *Staphylococcus aureus* in 31 (34.8%) and *Streptococcus pyogenes* in 26 (29.2%), followed by *Streptococcus pneumoniae* in 18 (20.2%) patients, *Haemophilus influenzae* in 9 (10.1%) and *Moraxella catarrhalis* in 5 (5.6%) patients. When comparing microbiological growth in synonasal secretion and tissue samples, the isolates matched in only 36 (40.4%) patients. Microbial growth was absent in six patients who were re-hospitalised.

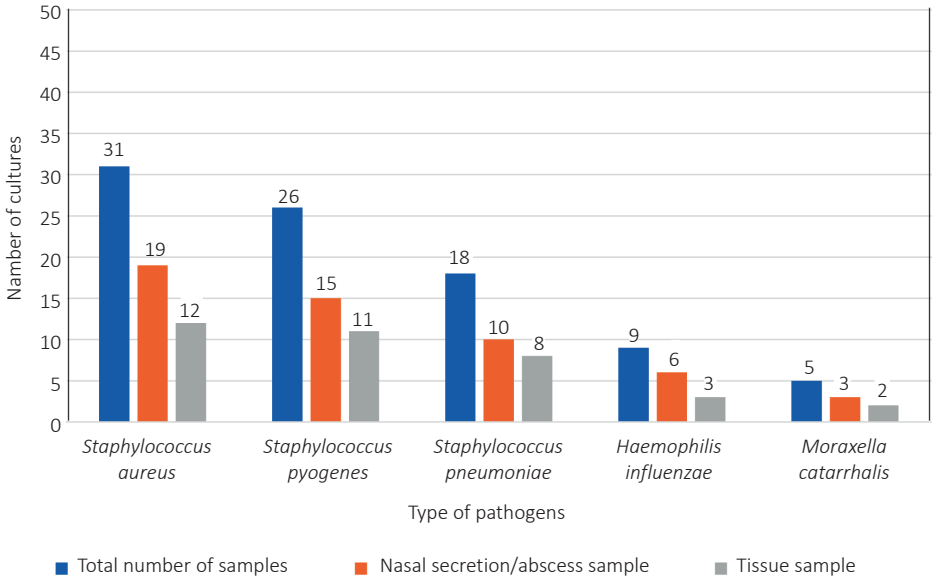
Clinical outcomes

Overall, 94.9% (74/78) of children received antibiotics before hospital admission. The most frequently prescribed antibiotics were amoxicillin, metronidazole and third-generation cephalosporins. Surgical intervention was required in 52.6% of patients who received antibiotics prior to admission. Overall, 83.5% of isolates obtained from these patients were sensitive to preclinically prescribed antibiotics. Preclinical antibiotic treatment had no significant effect on disease severity at the time of presentation according to Chandler classification ($p = 0.38$) and on treatment during hospital admission ($p = 0.33$). However, a significant association was found between age at admission and disease severity (Table 2).

The average length of hospital stay found to be 9.2 days (range 4–21 days). For younger and older children, the mean hospital stay was 7.7 and 13.6 days, respectively ($p = 0.03$). At the time of admission, 45% of the older children and 15.8% of the younger children who received pre-hospital antibiotics had grade III or IV orbital complications ($p < 0.001$). In addition, older children required surgery more often than younger children, 62.5% and 39,5%, respectively ($p < 0.01$). No recurrences were seen in older children, whereas three recurrences occurred in the group of children younger than seven years of age. These three patients were hospitalised more than once and subsequently required surgical intervention during their last hospitalisation.

Discussion

All children in this study received antibiotics before hospital admission, however, post-septal



Bacterial colonies isolated from samples
Бактериальные колонии, выделенные из проб

Table 2

Relationship between age and clinical characteristics

Таблица 2

Взаимосвязь между возрастом и клиническими характеристиками

	Younger age (<7 years) n (%)	Older age (>7 years) n (%)	Chi-squarc test /Mann-Whitney U test P value
Total number	38	40	0.76
Stage I and II at presentation	24 (63%)	30 (75%)	0.19
Stage III and IV at presentation	6(15.8%)	18 (45%)	<0.001*
Stage V at presentation	0(0)	0(0)	NA
Antibacterial therapy	37(97.4%)	37(92.5%)	0.38
Requirement for surgery	16(39.5)	25 (62.5)	<0.01*
Hospital stay duration (days)	7.7±3.6	13.6±4.5	0.03**

orbital complications occurred in two-thirds of the children. Despite antibiotic treatment, most children required surgery.

In this study, most children with stage I or II orbital complications responded well to intravenous antibiotics. In contrast, children with stage II or III complications did not improve with intravenous antibiotics, although the isolates were sensitive to the administered antibiotics. This supports the hypothesis that reduced antibiotic penetration through the bone into the affected areas is the cause of treatment failure.

Several studies have described that a subgroup of patients with SPOA can be successfully treated with antibiotics [13]. The response rate to drug treatment varies in most published studies. In this cohort, all patients with SPOA failed to respond to drug treatment, which required ESS to eliminate the pathological process. There is probably also a shift towards surgery, particularly in the older age group.

In addition, there is conflicting evidence in the literature that age is an important determinant of the development of orbital complications [8,12]. In this study, children older than seven years of age were significantly more likely to have stage III or IV orbital complications despite pre-hospital antibiotics and were more likely to require surgery. In comparison, most younger children who were treated with antibiotics before admission to the hospital had stage I complications and were more likely to improve with antibiotic treatment in the hospital. Our results support some existing evidence that infections in older children are complicated on admission, regardless of pre-hospital antibiotic treatment, and that younger children with stage I complications can be treated medically [12].

The most common micro-organism causing complicated ethmoiditis in the paediatric population is *S. aureus*, followed by *Streptococcus spp* [13, 14]. In the present study, *S. aureus* was the most frequently cultured bacteria. Compared to available studies, S. pneumoniae had a very high incidence rate in this cohort, possibly due to the fact that pneumococcal vaccine is not part of the routine immunisation programme.

In this study, CT imaging was shown to the majority of patients who failed medication to determine the next steps in the treatment of these patients. Imaging can help clinicians assess the need for surgical drainage in patients with visual impairment or in children who did not respond to antibacterial treatment.

The significance of this study is that it is based on clinical experience with orbital complications of ARS in the paediatric population. However, there are some limitations. The study is based on observational data, and due to its retrospective nature, some relevant information may have been missed in the data collection process.

Conclusions

In conclusion, orbital complications of acute sinusitis remain a persisting problem in pediatric otorhinolaryngology. In this study, the most important determinants of antibiotic treatment failure were stage II or III orbital complications at presentation and older age (>7 years of age). Early referral to the hospital should be considered for children >7 years with ARS as they present with worse orbital complications despite pre-hospital antibiotic therapy.

The authors declare having no competing interests.

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