Pediatric Orbital Cellulitis/Abscess: Microbiology and Pattern of Antibiotic Prescribing

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ABSTRACT

Background: The treatment for pediatric orbital cellulitis/abscess is trending towards intravenous antibiotic management alone in appropriate cases. Without cultures to guide therapy, knowing the local microbiology is of utmost importance in managing these patients.

Methods: We conducted a retrospective case series for patients age 2 months to 17 years, who were hospitalized between January 1, 2013, and December 31, 2019, to evaluate the local microbiology and pattern of antibiotic prescribing in pediatric orbital cellulitis.

Results and Discussion: Of 95 total patients, 69 (73%) received intravenous antibiotics only and 26 (27%) received intravenous antibiotics plus surgery. The most common organism cultured was *Streptococcus anginosus*, followed by *Staphylococcus aureus*, and group A streptococcus. Methicillin-resistant *Staphylococcus aureus* (MRSA) prevalence was 9%. MRSA-active antibiotics remain the most frequently used antibiotics.

BACKGROUND

Orbital cellulitis/abscess (OC) is a rare complication of acute rhinosinusitis that affects the periocular tissues posterior to the orbital septum. It can cause significant morbidities, such as vision loss, cavernous sinus thrombosis, and intracranial infection.[1] Although OC can happen at any age, it is more prevalent in the pediatric population.[2] Common clinical findings include orbital and periorbital edema and erythema, fever, pain with eye movement, diplopia, ophthalmoplegia, and proptosis. OC can be classified using groups 2 through 4 of the Chandler system, based on the extent and severity of infection: group 2 (orbital cellulitis), group 3 (subperiosteal abscess), and group 4 (intraorbital abscess).[3] Chandler group 1 (preseptal cellulitis) does not involve the orbital space and, therefore, generally does not cause intraorbital complications.

Children with OC require hospitalization for treatment and monitoring, with a multispecialty team of pediatricians, ophthalmologists, and otolaryngologists.[4] Intraorbital abscesses (Chandler group 4) represent less than 3% of total cases[5] and are typically treated surgically. With a less than 5% risk of intracranial complications for patients with orbital cellulitis (Chandler group 2) and subperiosteal abscess (Chandler group 3),[1] successful management with intravenous (IV) antimicrobials alone has been reported for many cases.[5,6] However, in the absence of surgical drainage and culture of the affected area, antibiotic selection cannot be targeted to specific pathogens, leading to variation in antibiotic selection within and between hospitals.[7] Data on the microbiology of orbital cellulitis in pediatrics are needed to guide selection of targeted antibiotics. In general, unnecessarily broad antibiotic exposure contributes to development of resistance, side effects, cost, and noncompliance after discharge. Since regional differences are reported for the bacterial causes of OC,[8] we aimed to report the local microbiology of OC to guide better empiric antimicrobial selection and decrease antibiotic overuse.[9]

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METHODS

Study Design and Participants

We conducted a retrospective case series of all pediatric patients, age 60 days to 17 years, admitted to a tertiary children's hospital with the diagnosis of OC between January 1, 2013, and December

31, 2019. The cohort was identified using the electronic medical record (EMR) system and the following diagnostic codes: ICD 9 - 376.01, 376.03 and ICD 10 - H05.011, H05.012, H05.013, H05.019, H05.021, H05.022, H05.023, H05.029, H05.121, H05.122, H05.123. Eligibility criteria included Chandler group 2, 3, or 4 OC confirmed by computed tomography obtained on admission. Exclusion criteria included patients with only preseptal cellulitis (Chandler group 1), those who were immunocompromised, and those with orbital infections secondary to trauma, orbital prostheses, or recent orbital/sinus surgery. The sample was divided in 2 groups for comparison based on therapeutic management: IV antibiotics alone (medical group) and IV antibiotics plus surgical intervention (surgical group).

Table 1. Patient Characteristics

	All Patients n = 95	Medical Group n = 69	Surgical Group n = 26	
	N (%) or Median IQR	N (%) Median IQR	N (%) Median IQR	*P* value
Age, years	8.1 (4.6-11.4)	7.0 (4.3-10.3)	10.7 (5.9-12.2)	0.009
Gender, male	64 (67)	45 (65)	19 (73)	0.62
Race[a]				0.72
White	53 (61)	40 (62)	13 (57)	
African American	33 (38)	23 (36)	10 (43)	
Native Hawaiian/Pacific Islander	1 (1)	1 (2)	—	
Ethnicity				0.34
Not Hispanic/Latino	74 (83)	54 (81)	20 (91)	
Hispanic/Latino	15 (17)	13 (19)	2 (9)	
Length of stay, days	3.8 (2.9-4.8)	3.6 (2.7-4.6)	4.7 (3.8-5.2)	≤ 0.001
Chandler group				≤ 0.001
Group 2 (orbital cellulitis)	33 (35)	33 (48)	0 (0)	
Group 3 (subperiosteal abscess)	62 (65)	36 (52)	26 (100)	
Signs of retinal or optic nerve compromise[b]	1 (1)	0 (0)	1 (4)	0.27
Frontal sinusitis or intracranial extension	24 (25)	14 (20)	10 (39)	0.11
Repeat CT scan or MRI	18 (19)	10 (15)	8 (31)	0.08
Worsening of disease on repeat image	4 (22)	0 (0)	4 (50)	0.023
Readmission within 7 days[c]	1 (1)	0 (0)	1 (4)	0.28
Readmission within 30 days	2 (2)	1 (2)	1 (4)	0.48
Recurrence (> 30 days)	3 (3)	2 (3)	1 (4)	> 0.99

Abbreviations: IQR, interquartile range; CT, computed tomography; MRI, magnetic resonance imaging.
[a]Excludes those who refused to answer or did not answer/declined.
[b]One patient with unknown data was excluded from this analysis.
[c]Three patients with unknown data were excluded from this analysis.

Outcome Measures and Other Variables

The primary aim of the study was to describe the microbiology of OC. Intraoperative cultures from the abscess and/or sinus were recorded, including the patterns of resistance to commonly used antibiotics (eg, clindamycin, methicillin). Nasal, conjunctival, or other surface cultures were not included. Blood culture results were recorded when available. Antibiotics started on admission, and antibiotics prescribed at time of discharge were recorded with associated length of therapy. Other variables collected include demographic data, clinical indicators of disease severity (signs of retinal or optic nerve compromise, frontal sinusitis, or intracranial extension), length of hospital stay, Chandler groups, and signs of possible treatment failure (repeat imaging, readmission).

Statistical Analysis

Data are reported as median and interquartile range (IQR) or n (%). We compared differences between the medical and the surgical groups using Fisher exact test for categorical variables and the Mann-Whitney-Wilcoxon test for continuous variables. A *P* value < 0.05 was considered significant. Statistical analyses were conducted by using SPSS version 26.0 (IBM Corp, Armonk, New York) and SAS version 9.4 (SAS Institute Inc, Cary, North Carolina).

RESULTS

Cohort Characteristics

We reviewed the medical records of 99 patients with OC and excluded 4 due to immunocompromised state (n = 1), trauma (n = 1), or wrong diagnosis (n = 2). Ninety-five patients with pediatric OC were included: 33 with orbital cellulitis (Chandler group 2) and 62 with subperiosteal abscess (Chandler group 3). No cases of intraorbital abscess (Chandler group 4) were identified. The median age (years) was 8.1 (IQR 4.6-11.4); 67% were male (n = 64). (Table 1) Twenty-six (42%) patients with subperiosteal abscess underwent orbital surgery, sinus surgery, or both. Most surgeries were completed within the first day following admission. Thirty-six (58%) patients with subperiosteal abscess were managed with IV antibiotics alone. All 33 patients with orbital cellulitis without subperiosteal abscess were managed medically. Of the total cohort of 95 patients, 69 (73%) did not have surgery. Median length of stay for all patients was 3.8 days (IQR 2.9-4.8), 4.7 days (IQR 3.8-5.2) for patients who underwent surgery, and 3.6 days (IQR 2.7-4.6) for those treated medically with IV antibiotics alone.

Microbiology of Orbital Cellulitis/Abscess

Of 95 total patients, orbital and/or sinus cultures were obtained for all 26 surgical group patients but none of the 69 medical group patients. The organisms identified from blood, orbit, and sinus cultures are listed in Table 2. Eighteen of 22 (82%) orbital cultures, 14 of 18 (78%) sinus cultures, and 2 of 39 (5%) blood cultures were positive. When the same organism grew in more than 1 cul-

Table 2. Microbiology of Orbital Cellulitis/Abscess at Local Institution Between January 2013 and December 2019

Organism	Orbital Culture (18/22 Positive Cultures)	Sinus Culture (14/18 Positive Cultures)	Blood Cultures (2/39 Positive Cultures)	No. of Patients With at Least 1 Positive Culture
Strep anginosus group	10	6	1	13
Group A streptococcus	3	1	-	4
Strep pneumoniae	1	1	-	2
Streptococcus viridans	0	2	-	2
MRSA	1	2	-	2
MSSA	1	1	1	2
Hemophilus influenzae	2	2	-	3
Peptostreptococcus	1	-	-	1
Rotha mucialginosa	1	-	-	1
Parvimonas micra	2	-	-	2
Fusibacterium necrophorum	1	-	-	1
Eikenella corrodens	1	1	-	2
Corynebacterium sp	-	1	-	1
Moraxella catarrhalis	-	1	-	1
Neisseria sp	-	1	-	1
Polymicrobial cultures (n, %)	4 (18)	3 (17)	0 (0)	6 (23)
Anaerobic cultures (n, %)	4 (18)	1 (6)	0 (0)	4 (15)

Abbreviations: MRSA, methicillin-resistant *Staphylococcus aureus;* MSSA, methicillin-susceptible *Staphylococcus aureus.*

Table 3. Antibiotics in the Medical and Surgical Groups

	Medical Group		Surgical Group		
	N	N (%) or Median (IQR)	N	N (%) or Median (IQR)	*P* value
Received antibiotics before presentation	69	35 (51)	26	11 (42)	0.50
Antibiotics started at time of admission[a]					
IV clindamycin	69	68 (99)	26	21 (81)	0.005
Ampicillin/sulbactam	69	64 (93)	26	20 (77)	0.065
Vancomycin	69	1 (1)	26	5 (19)	0.005
Ceftriaxone	69	5 (7)	26	3 (12)	0.68
Other	60	0 (0)	26	4 (15)	0.005
≥2 antibiotics at admission	69	68 (99)	26	26 (100)	>0.99
Antibiotic combination at admission	69		26		0.008
IV clindamycin + ampicillin/sulbactam		62 (90)		17 (65)	
Clindamycin + ceftriaxone		4 (6)		2 (8)	
Vancomycin + ampicillin/sulbactam		1 (1)		2 (8)	
Other		2 (3)		5 (19)	
Antibiotics at discharge[a]					
Amoxicillin/clavulanate	69	63 (91)	26	19 (73)	0.040
Oral clindamycin	69	53 (77)	26	11 (42)	0.003
Other	69	4 (6)	26	4 (15)	0.21
Antibiotic combination at discharge	69		26		≤0.001
Amoxicillin/clavulanate alone		12 (17)		11 (43)	
Amoxicillin/clavulanate + oral clindamycin		47 (68)		7 (27)	
Oral clindamycin alone		6 (9)		3 (11)	
Amoxicillin/clavulanate + other (no clindamycin)		4 (6)		1 (4)	
None		0 (0)		1 (4)	
Other		0 (0)		3 (11)	
Length of oral antibiotics at discharge, days	68	18 (14-21)	25	21 (14-21)	0.37
≥2 antibiotics at discharge	69	51 (74)	26	9 (35)	0.001
MRSA antibiotic at discharge	69	55 (80)	26	10 (39)	≤0.001

[a]May have more than one type of antibiotic prescribed (at time of admission or discharge)
Abbreviation: IV, intravenous; MRSA, methicillin-resistant *Staphylococcus aureus.*

ture from the same patient, the organism was counted as 1 (see column "Number of patients with at least 1 positive culture"). The most common organism cultured was *Streptococcus anginosus* group, a subset of the viridans group streptococci (n = 13), followed by *Staphylococcus aureus* (n = 544) and group A streptococcus (n = 4). Of the 4 *Staphylococcus aureus* organisms recovered, 2 were methicillin-resistant *Staphylococcus aureus* (MRSA) and clindamycin-susceptible, and 2 were methicillin-susceptible. The MRSA prevalence of patients with a pathogen recovered was 9% (2/23). Two of 39 blood cultures obtained were positive and, in both cases, organisms from blood cultures were concordant with the surgical cultures (*Streptococcus anginosus* group and methicillin-susceptible). Nine patients had simultaneous positive orbital and sinus cultures, and these cultures were concordant in only 5 cases (55%). (See Appendix: Supplemental Table.)

Antimicrobial Therapy

Ninety-four patients (99%) were started on dual antibacterial therapy on admission. The most common IV antibiotic combination used was clindamycin plus ampicillin/sulbactam. At the time of discharge, 74% of patients treated with IV antibiotics only (medical group) and 35% of patients treated with surgery plus IV antibiotics (surgical group) were transitioned to dual oral antibiotic therapy ($P = 0.001$). MRSA-active antibiotics were prescribed at discharge in 80% of patients in the medical group and 39% of patients in the surgical group ($P \leq 0.001$). The most common oral antibiotic combination used was clindamycin plus amoxicillin/clavulanate. Dual therapy was prescribed at discharge for a duration of 14 to 21 days (IQR) in both medically and surgically managed patients (Table 3).

DISCUSSION

Since almost 80% of patients with OC and over 50% with subperiosteal abscess are treated without surgery,[5] operative cultures to guide antimicrobial therapy are lacking

in the majority of patients. Therefore, antimicrobial choice for these "antibiotics only" patients demands extrapolation from the local microbiology and antimicrobial resistance patterns identified from surgical cases. In our study cohort, the most common organism isolated from orbital, sinus, and blood cultures of patients with OC who underwent surgery was *Streptococcus anginosus* group, followed by *Staphylococcus aureus* and group A streptococcus, consistent with other midwestern US reports,[6,8] while our low rate of MRSA differs from some other reports.[8]

Although the MRSA prevalence in surgical cases in our study was low (9% of positive cultures), 80% of the patients managed medically—without a culture to guide antibiotic selection—were discharged on MRSA-active antibiotics (clindamycin or trimethoprim-sulfamethoxazole). In our hospital, MRSA prevalence has been low for the past 2 decades: 11% of all positive cultures during the years 2002-2012[6] and 9% of all positive cultures during 2013-2019, the period of the current study. Of the 2 patients with MRSA OC identified in this study, 1 had a known recent exposure to a family member with MRSA cellulitis.

Lack of culture results from the patients managed medically make firm recommendations on antimicrobial management difficult. While nasal swabs showing the absence of MRSA colonization have a high negative predictive value for exclusion of MRSA as a cause of community-acquired pneumonia in adults,[10] this has not been studied in patients with OC. Given the lack of concordance we found between sinus and orbital culture results, further study would be needed before one could use the negative result of a MRSA nasal swab to confidently stop coverage for MRSA in a pediatric patient with OC. Until such data are available, antimicrobials to cover the predominant local pathogens—streptococci and anaerobes—might be supplemented by antibiotics directed toward MRSA, depending on local prevalence and patient history.[7]

CONCLUSIONS

Our single-center retrospective case series showed that the most common organism cultured in surgical patients with OC was *Streptococcus anginosus*, followed by *Staphylococcus aureus* and group A streptococcus. Prevalence of MRSA was low in our population, but therapy with MRSA-active antibiotics was still used in the majority of pediatric patients with OC.

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REFERENCES

1. Reynolds DJ, Kodsi SR, Rubin SE, Rodgers IR. Intracranial infection associated with preseptal and orbital cellulitis in the pediatric patient. *J AAPOS*. 2003;7(6):413-417. doi:10.1016/j.jaapos.2003.09.013

2. Santos JC, Pinto S, Ferreira S, Maia C, Alves S, da Silva V. Pediatric preseptal and orbital cellulitis: a 10-year experience. *Int J Pediatr Otorhinolaryngol*. 2019;120:82-88. doi:10.1016/j.ijporl.2019.02.0032.

3. Chandler JR, Langenbrunner DJ, Stevens ER. The pathogenesis of orbital complications in acute sinusitis. *Laryngoscope*. 1970;80(9):1414-1428. doi:10.1288/00005537-197009000-00007

4. Jabarin B, Marom T, Gavriel H, Eviatar E, Pitaro J. Orbital complications secondary to acute rhinosinusitis in toddlers: a unique age group. *Int J Pediatr Otorhinolaryngol*. 2019;121:46-49. doi:10.1016/j.ijporl.2019.03.002

5. Zhao EE, Koochakzadeh S, Nguyen SA, Yoo F, Pecha P, Schlosser RJ. Orbital complications of acute bacterial rhinosinusitis in the pediatric population: a systematic review and meta-analysis. *Int J Pediatr Otorhinolaryngol*. 2020;135:110078. doi:10.1016/j.ijporl.2020.110078

6. Liao JC, Harris GJ. Subperiosteal abscess of the orbit: evolving pathogens and the therapeutic protocol. *Ophthalmology*. 2015;122(3):639-647. doi:10.1016/j.ophtha.2014.09.009

7. Markham JL, Hall M, Bettenhausen JL, Myers AL, Puls HT, McCulloh RJ. Variation in care and clinical outcomes in children hospitalized with orbital cellulitis. *Hosp Pediatr*. 2018;8(1):28-35. doi:10.1542/hpeds.2017-0040

8. Burek AG, Melamed S, Liljestrom T, et al. Evaluation and medical management of the pediatric patient with orbital cellulitis/abscess: a systematic review. *J Hosp Med*. 2021;16(11):680-687. doi:10.12788/jhm.3707

9. Gerber JS, Newland JG, Coffin SE, et al. Variability in antibiotic use at children's hospitals. *Pediatrics*. 2010;126(6):1067-1073. doi:10.1542/peds.2010-1275

10. Parente DM, Cunha CB, Mylonakis E, Timbrook TT. The clinical utility of methicillin-resistant Staphylococcus aureus (MRSA) nasal screening to rule out MRSA pneumonia: a diagnostic meta-analysis with antimicrobial stewardship implications. *Clin Infect Dis*. 2018;67(1):1-7. doi:10.1093/cid/ciy024

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