

# Predicting the Need for Surgical Intervention in Pediatric Orbital Cellulitis

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- **PURPOSE:** To investigate the predictive value of the complete ophthalmic examination at first presentation in foreseeing the need for surgery in patients with pediatric orbital cellulitis.
- **DESIGN:** Retrospective observational case series.
- **METHODS:** We reviewed 136 cases of radiographically confirmed orbital cellulitis between 2004 and 2012 at Children's Hospital Colorado. The presenting ophthalmic examinations, imaging results, medical and surgical interventions, and clinical complications were recorded. The main outcome measures were ophthalmic examinations on presentation, medical or surgical interventions, and complications.
- **RESULTS:** The median age was 6.5 years. Of the patients, 56 (41%) underwent surgical intervention, and 80 patients (59%) were managed medically. Patients requiring surgery had higher rates of extraocular motility (EOM) restriction (78.6% vs 38.8%  $P < 0.01$ ), proptosis (64.3% vs 21.2%,  $P < 0.01$ ), elevated intraocular pressure (IOP) (35.7% vs 12.5%,  $P < 0.01$ ), and age over 9 years (58.9% vs 20.0%,  $P < 0.01$ ). Using any combination of the above risk factors at presentation, the probability of surgical intervention increases from 7% (95% confidence interval [CI] 1%–13%) with zero risk factors to 95% (95% CI 89%–100%) with 4 risk factors.
- **CONCLUSIONS:** In pediatric orbital cellulitis, the likelihood of surgical intervention can be estimated accurately based on the ophthalmic examination on initial presentation to the hospital. Risk factors for surgery include age older than 9 years, proptosis, EOM restriction, and elevated IOP. These factors may be used to identify patients at high risk for failure of medical management early in the clinical course. (Am J Ophthalmol 2014;158:387–394. © 2014 by Elsevier Inc. All rights reserved.)

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**O**RBITAL CELLULITIS IS A SERIOUS INFECTION occurring most commonly in children, and it can result in grave complications, including blindness, cavernous sinus thrombosis, meningitis, subdural empyema, brain abscess, and death.<sup>1</sup> The severity of these potential outcomes emphasizes the importance of rapid clinical identification, risk stratification and treatment.<sup>2,3</sup>

The classic findings of orbital cellulitis are chemosis, proptosis, extraocular motility (EOM) restriction, loss of visual acuity, and an afferent pupillary defect.<sup>4–6</sup> Fever and leukocytosis are also commonly present and provide a basis for monitoring severity of infection and management.<sup>7,8</sup> Although the classic physical findings of orbital cellulitis are well known, no prior studies have assessed the implications of the initial ophthalmic examination in a systematic fashion.<sup>9,10</sup>

The purpose of this review is to evaluate the relevance and predictive value of the initial ophthalmic examination in assessing the need for surgical intervention. If, in fact, initial ophthalmic findings can predict the need for surgical intervention, pediatric patients could be spared valuable time in expectant management, and potential morbidities associated with prolonged hospital stays could be minimized.

## METHODS

THIS IS A RETROSPECTIVE CHART REVIEW OF ALL PATIENTS presenting to Children's Hospital Colorado who were 18 years of age or younger between January 1, 2004, and November 1, 2012, with orbital infection. Prior to undertaking the study, the Colorado Multiple Institutional Review Board ruled that the protocol qualified for exempt approval under category 4 and was determined to meet criteria for waiver of Health Insurance Portability and Accountability Act authorization. This study was conducted in accordance with the tenets of the Declaration of Helsinki as well as all applicable state and federal laws.

Medical records with the following International Classification of Diseases (ICD-9) codes were identified for review: orbital cellulitis or abscess (376.01), orbital periostitis (376.02), orbital osteomyelitis (376.03), orbital myositis (376.12), acute inflammation of orbit, unspecified (376.00), or face (682.0). This search yielded 452 patients. All included patients had orbital imaging that demonstrated

sinusitis and orbital soft-tissue stranding with or without subperiosteal abscess or intraorbital abscess. Patients with orbital cellulitis or abscess secondary to trauma, recent surgery, anatomic abnormalities, malignancy, or immunodeficiency were excluded, as were patients with noninfectious orbital inflammation, ultimately yielding 136 patients for inclusion in the study.

Demographic characteristics included age, gender and ethnicity. Charts were reviewed for duration of eye symptoms and antibiotic use prior to admission. Ophthalmic examination included visual acuity, pupillary examination, extraocular motility, intraocular pressure (IOP) measured by Tono-Pen (Reichert Technologies, Buffalo, NY) if possible and by palpation if not possible, and the presence or absence of chemosis and relative proptosis. The clinical course of each patient was recorded in detail, including type of surgical intervention, specific antibiotic use and any significant complications that occurred during hospitalization or within 1 month of discharge. Complications were defined as readmission within 1 month of discharge, residual visual impairment secondary to orbital cellulitis, reoperation, and death.

Ophthalmic examination findings were collected only from complete consultation reports from the ophthalmology service. Visual acuity and IOP were recorded for all patients. A difference in visual acuity of 2 or more Snellen lines between the affected eye and the unaffected eye was considered significant if not previously noted in patients' medical records. IOP was considered elevated if it exceeded 21 mm Hg in the affected eye. In cases where IOP by Tono-Pen was unable to be obtained, "soft to palpation" was considered normal, while "firm to palpation" was considered elevated. Proptosis was recorded as present if explicitly noted in the initial examination.

Statistical analysis was performed using the chi-square test for determining whether there were differences in demographic and clinical characteristics between medically and surgically managed patients. Estimation of the odds of surgery was found via logistic regression models, both for univariable and multivariable regression models. Each demographic factor's potential association with the odds of patients' undergoing surgery was investigated and reported on using individual univariable logistic regression models. The clinical observations used in the multivariable analysis were age, proptosis, EOM restriction, and elevated IOP.

A receiver operating characteristic curve and the area under the curve are presented for the multivariable regression model. Receiver operating curves plot the sensitivity (the true positive rate) on the y axis and 1-specificity (the false-positive rate) on the x axis. If the plot falls on the y = x plot line, the regression model is no more informative than the proverbial coin toss. The evaluation of the informative power of a receiver operating curve is the area under the curve, which is the probability of the logistic regression model ranking any random case higher than any random control.

**TABLE 1.** Demographic Characteristics in Pediatric Patients with Orbital Cellulitis

Characteristic	Value (n = 136)
Median age	6 years (mean = 7.0 years)
Male	87 (64%)
Female	49 (36%)
White	97 (71%)
Hispanic	18 (13%)
African-American	14 (10%)
Asian	2 (1%)
Other	7 (5%)

The data were collected in a Microsoft Excel Workbook and were exported to a .csv file for import into R v 3.0.1 (2013-05-16) for data analysis. Graphics were generated via the ggplot2 package. Statistical significance was set at the 0.05 level.

## RESULTS

IN TOTAL, 452 PATIENTS WERE IDENTIFIED DURING INITIAL chart review. We excluded 316 patients due to diagnoses of preseptal cellulitis, facial abscess, dental abscess, neck abscess, malignancy, allergic reaction, immunosuppression, or incomplete records. All patients admitted to Children's Hospital Colorado younger than 18 years of age, with confirmation of orbital cellulitis on computed tomography (CT) scan, and without the above exclusion criteria, were included in the study. Ultimately, 136 patients were included. Of those patients, 74 (54%) had subperiosteal abscess, 9 (7%) had intraorbital abscess, and 53 (39%) had orbital cellulitis without evidence of abscess. All 136 patients were admitted to the hospital. The average duration of stay was 4.90 days (range, 2–21 days).

The demographic data are shown in [Table 1](#). The median age was 6 years (mean = 7.0 years, range, 1 month-18 years), with a male predominance (64%,  $P = 0.0011$ ). [Figure 1](#) shows the distribution of age in all patients with orbital cellulitis, as well as that of those who underwent surgery.

During their hospitalization, 56 patients (41%) underwent surgery. Surgery took place, on average, on hospital day 1.8 (range, 1–5). The most common indications for surgery were a worsening clinical course on medical therapy alone (20 patients), severe sinus disease necessitating functional endoscopic sinus surgery with takedown of the medial orbital wall (16 patients), large abscess (9 patients), and signs of orbital compartment syndrome (7 patients).

Patients who ultimately required surgery were older (8.1 vs 5.7 years,  $P < 0.01$ ) and were more likely to present with proptosis (64.3% vs 21.2%,  $P < 0.01$ ), EOM restriction (78.6% vs 38.8%,  $P < 0.01$ ), elevated IOP (35.7% vs

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