Abstract

Objective. Eyelid edema in children is one of the signs of orbital complications secondary to acute rhinosinusitis, and identifying abscess formation is crucial for management decision. The objective of this study is to determine whether there are different computed tomography scan abscess dimensions and volumes in children requiring medical versus surgical management for subperiosteal orbital abscess (SPOA).

Study Design. Case series with chart review.

Setting. The study was conducted at Assaf Harofeh Medical Center.

Subjects and Methods. Clinical and radiological parameters of 95 children admitted with eyelid edema between January 2005 and December 2007 were studied.

Results. Of 95 cases of orbital cellulitis, a total of 48 children with sinogenic orbital complications with a mean (SD) age of 4.03 (3.46) years were included. No significant difference was found between the surgically and medically treated SPOA groups regarding the use of preadmission antibiotic and clinical presentation. Statistically significant larger abscesses in the surgically treated group were noted (mean volume 1.389 vs 0.486 mL in the conservatively treated group; \( P = .013 \)) and a longer mean anterior-posterior and medial-lateral dimension (\( P = .001 \) and .017, respectively).

Conclusion. Children presenting with significant or progressing ocular findings or failure to improve after 48 hours of medical therapy, together with an abscess volume of more than 0.5 mL, a length greater than 17 mm, and a width greater than 4.5 mm, should be strongly considered to have surgical drainage.

Keywords

subperiosteal orbital abscess, sinusitis, CT scan, surgical treatment

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complications, and lack of improvement within 48 hours despite appropriate medical therapy.\textsuperscript{3,12} There are no clear guidelines regarding the actual size of an SPOA up to which conservative treatment is effective and from which surgery is required. Harris\textsuperscript{13} claimed that medial SPOA of modest size can be treated successfully medically. Since then, only a few authors have addressed the size of the SPOA as a possible indication for surgery.\textsuperscript{14-16} The aim of this study is to investigate in a historical prospective method the influence of abscess dimensions according to the CT scan on management decisions in cases of children with a sinogenic OC, including the need for surgical intervention, as well as the influence of clinical presentation.

**Patients and Methods**

The study was approved by the Assaf Harofeh Medical Center Institutional Review Board. A historical prospective study on 95 children (from birth to 18 years) with orbital cellulitis admitted to our institute, from January 2005 to December 2007, was carried out.

Forty-eight children with symptoms and physical findings suggesting ARS were included in our study, whereas 47 children had a history suggestive of local trauma, insect bite, foreign bodies, allergic reaction, and conjunctivitis and thus were excluded (Figure 1). The selected children were divided into 4 groups: CT scan–proven SPOA needing surgical evacuation, CT scan–proven SPOA treated conservatively, CT scan–proven preorbital cellulitis treated conservatively, and clinically diagnosed (without CT scan) preorbital cellulitis treated conservatively. Analysis of the parameters of the first 2 groups of children with radiologically proven SPOA was the essence of this study.

Age, gender, symptoms, physical findings, body temperature, complete white blood count and differential, C-reactive protein (CRP) levels, CT findings, treatment before and during admission, surgical treatment, outcome, and the final diagnosis were analyzed and compared between the groups. When the CT scan report indicated an abscess, CT scans were reevaluated by one of the senior authors (E.E.) and reviewed for the number of sinuses involved, abscess location (medial, lateral, superior, inferior), orbital fat changes (yes/no), and abscess measurements and volume calculations. The volumes of the abscess were calculated by using the ellipsoid formula \( \frac{4}{3} \pi \cdot abc \), which better correlates with the ellipsoid shape of an abscess on the CT scan findings, rather than a simple multiple of the abscess linear dimensions.

All children were evaluated and followed by the ophthalmology service. Ocular exams included assessment of vision when possible, pupillary function, preorbital edema, periocular erythema, chemosis, proptosis, intraocular pressure, and retinal appearance.

Endonasal endoscopic drainage, when indicated, was performed under general anesthesia in all surgically treated children, performing complete ethmoidectomy and removing extensively the lamina papyracea. The nasal cavity was irrigated and the nose packed with a Merocel tampon.\textsuperscript{17}

For statistical purposes, \( \chi^2 \) with Fisher exact test and the Mann-Whitney test were used to compare categorical data, whereas continuous variables were analyzed with the Student \( t \) test.

**Results**

A total of 48 children with eyelid edema, 29 males and 19 females, who fit the criteria were included in our study. The mean (SD) age was 4.03 (3.46) years (range, 1 month to 18 years), with the largest group younger than age 4 years. Our cohort was divided into 4 groups. Group 1 included 19 (39.5%) children in which preseptal cellulitis (Chandler’s stage 1) was clinically diagnosed, and group 2 included 8 patients in which preseptal cellulitis was radiologically proven (16.6%). Twenty-one (43.7%) children were included in groups 3 and 4 in which medial SPOA was proven radiologically; 10 (47.6%) of them (group 3) were operated on, and 11 were treated conservatively (group 4) (Figure 1). The right and left sides were equally involved in the entire group and in each subgroup. All children were examined by a pediatrician, ophthalmologist, and otolaryngologist.

Nineteen (37.2%) children in the entire cohort received oral systemic antibiotic treatment because of symptoms and signs of ARS prior to admission either before or after the presentation of eyelid edema. Most of the children were treated with amoxicillin-clavulnate, followed by amoxicillin, cephalaxin, and ceftriaxone. No correlation was found between the

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**Table 1. Chandler’s Classification**

<table>
<thead>
<tr>
<th>Stage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Inflammatory edema (preseptal cellulitis)</td>
</tr>
<tr>
<td>2</td>
<td>Orbital cellulitis</td>
</tr>
<tr>
<td>3</td>
<td>Subperiosteal abscess</td>
</tr>
<tr>
<td>4</td>
<td>Orbital abscess</td>
</tr>
<tr>
<td>5</td>
<td>Cavernous sinus thrombosis</td>
</tr>
</tbody>
</table>

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**Figure 1. Evaluation and treatment of 95 patients with orbital cellulitis. CT, computed tomography; SPOA, subperiosteal orbital abscess.**
use of preadmission antibiotics and the presence of an abscess or the need for surgical treatment ($P = .475$).

Clinical signs and symptoms could not be retrieved from all patient files as they were not documented in all children’s notes, and therefore the rates were calculated according to whether positive or negative signs or symptoms were reported. These included rhinorrhea, which was found in 39 of 46 children (84.7%), fever in 39 of 45 (86.6%), cough in 16 of 40 (40%), and headache in 10 of 11, with no significant difference between the subgroups. Proptosis and ophthalmoplegia were found in 7 (14.5%) and 9 (18.7%) children, respectively, but only in those with radiologically proven SPOA, and were statistically significantly more common in children who underwent a CT scan ($P = .015$ and .03, respectively). The fact that these signs were observed only in the CT scan–proven SPOA group and not in children in other groups (negative predictive value [NPV] = 100%) makes these parameters most important in the decision to perform a CT scan. Yet, no correlation was found between these signs and the type of treatment, neither conservative nor surgical.

Leukocytosis, which was present in most children, did not differ significantly in the groups, nor did granulocytosis, lymphocytosis, mononcytosis, and the mean levels of CRP.

A CT scan was performed in all 21 SPOA cases and in 8 children who presented with clinical periorbital cellulitis, but no SPOA was demonstrated on the CT scan. Abscess measurements were available in 19 (90.4%) of the 21 children with proven SPOA, 9 of 11 children treated conservatively, and in all 10 children treated surgically (Table 2).

Significantly larger abscesses in the surgically treated group were noted, with a mean abscess volume of 1.389 mL in the surgically treated group compared to only 0.486 mL in the conservatively treated group ($P = .013$). When comparing the 3 dimensions of the abscess between the groups, significantly longer mean anterior-posterior dimensions and lateral-medial dimensions were measured in the latter group ($P = .01$ and .017, respectively), as was a tendency toward longer mean inferior-superior dimensions.

Radiological findings of sinusitis were demonstrated in all children with available CT scans. Ethmoid sinususes were opacified in all cases, 23 of 25 (92%) had maxillary involvement, 9 of 25 (36%) had sphenoid sinus involvement, and 7 of 23 (30.4%) had frontal sinus involvement. However, no statistical difference was found in sinus involvement between our subgroups.

All children were hospitalized and received intravenous (IV) antibiotics. Forty (83.3%) received amoxicillin/clavulanate, 5 (10%) received Rocephin (ceftriaxone), (8.3%) received concomitant clindamycin and 1 concomitant metronidazole, and only 1 (2%) received cefuroxime. Sixteen (33.3%) children received topical nasal decongestants in addition.

### Discussion

Sinogenic OC can lead to catastrophic outcomes if not treated appropriately. SPOA is one of the most common yet severe stages of sinogenic OC as described by Chandler et al in 1970, whereas the more advanced and dangerous complications, meaning orbital abscess and cavernous sinus thrombosis, are far more rare. Although stages 1 and 2 in Chandler’s classification are usually treated conservatively, and Chandler’s stages 4 and 5 are usually treated surgically, a controversy exists regarding the most appropriate treatment modality for Chandler’s stage 3 SPOA.

The first step while treating patients with sinogenic OC is to establish their clinical staging. The presence of a serious or deteriorating ophthalmologic status and no response to medical therapy will eventually move the treating physician forward to imaging evaluation because the presence of an abscess, either subperiosteal (Chandler’s stage 3) or orbital (Chandler’s stage 4), will be highly suspected and surgery might be considered.

Many have advocated the use of different clinical parameters when deciding whether to use the CT scan to demonstrate a suspected abscess formation. In our study, we found a strong statistical correlation between the presence of ophthalmoplegia and proptosis and the presence of an SPOA, as children who did not have these clinical signs did not have an SPOA according to the CT scan findings (NPV = 100%). This shows the importance of a routine ophthalmological evaluation to rule out the presence of these 2 signs and, when one of them is observed, the importance of performing a CT scan to prove the presence of an abscess.

The exact role and timing of surgical intervention for SPOA remain controversial. Several authors have suggested that all patients with a proven SPOA should be treated surgically, whereas others in more recent studies have shown that SPOA in children younger than age 9 years is amenable to medical treatment with close observation and serial ophthalmological examinations, with high success rates. Only a couple of articles in the English literature have demonstrated a correlation between abscess size and the success rates of medical treatment. Ryan et al reported that 81% of patients with a radiographic abscess width smaller than 10 mm were successfully treated medically, whereas 92% of those with an abscess width larger than 10 mm underwent...
surgical intervention. Oxford and McClay\textsuperscript{14} evaluated all abscess dimensions according to the CT scan, as we did in our study. However, the volume calculation comprised a simple multiple of linear dimensions, which provided a less accurate estimation of the abscess volume than our calculation. According to our observation of the CT scan findings, we concluded that the abscess formation is always elliptical in shape, and thus all our volume calculations of the abscess were according to the ellipsoid formula $V = \frac{4}{3} \pi abc$. In the studies by Oxford and McClay\textsuperscript{14} and Ryan et al.,\textsuperscript{16} a significant difference was found in all dimensions of the abscesses between the medically and surgically treated groups. The mean calculated volume in the medically treated group in their study was 0.25 mL (or 0.105 mL when calculated according to the ellipsoid formula used by us) compared to 0.486 mL in our study. In addition, the mean calculated volume in their surgically treated group was 4.380 mL (or 1.918 mL when calculated according to the ellipsoid formula) compared to 1.389 mL in our group. The enormous difference of more than 17-fold between the surgically and medically treated groups in their study compared to less than 5-fold difference between these groups in our study suggests narrower selective criteria for medical treatment in the Oxford and McClay\textsuperscript{14} study compared to ours, which might explain why in our study, only 47% of the patients were operated upon compared to 58% in the Oxford and McClay\textsuperscript{14} study.

Although much bigger abscesses in the presented study were treated medically, a significant difference was noted with regard to 2 of the measured dimensions of the abscess and the calculated volume. However, one of the abscess dimensions did stand out with a very high statistically significant difference between the surgically and medically treated groups—the length of the abscess ($P = .01$). We assume that the possible correlation of the length of the SPOA with the need for surgical treatment lies in the anatomical structure of the orbit. The orbit has roughly the shape of a quadrilateral pyramid whose base corresponds to the orbital margin and whose apex is the bar of bone between the optic foramen and the medial end of the superior orbital fissure, the length of which is approximately 42 mm\textsuperscript{2} and contains the optic nerve and associated vessels.\textsuperscript{22} Pathophysiologically, a space-occupying lesion at the orbital apex will have a greater impact on the inner pressure of the contents of the orbital apex than a similar lesion of the same volume situated more superficially, implying that a longer SPOA will have a greater impact on the clinical presentation of the patient than the other dimensions and hence on the decision-making process of the treating surgeon. Although the use of the ellipsoid formula for calculating the abscess volume is feasible, the width and length of the abscess might be as effective for management decisions.

Our approach to patients with suspected orbital complications secondary to sinusitis includes broad-spectrum intravenous antibiotics; intranasal saline irrigation and decongestants; ophthalmology consultation, including frequent ocular examinations; and contrasted axial and coronal CT scans when clinical signs suggest ophthalmoplegia or proptosis and in cases of failure of conservative treatment. According to the presented results, children presenting with significant or progressing ocular findings or failure to improve after 48 hours of medical therapy together with an abscess volume of more than 0.5 mL, a length greater than 17 mm, or a width greater than 4.5 mm should be strongly considered for surgical drainage.

**Conclusion**

We present a historical prospective study that clarifies the parameters differentiating OC due to the formation of an abscess from less dangerous stages of sinonogenic OC. The volume, anterior-posterior axis, and medial-lateral axis of the abscess were proven to be significantly longer in the surgically treated children and might serve as an indicator for surgical treatment of SPOA. Ophthalmologic signs are proven in our study to be an indication for performing a CT scan.

**Author Contributions**

Haim Gavriel, planner of conception and design, analysis and interpretation of data, drafting the article, and final approval of the version to be published; Eyal Yeheskeli, contribution to conception and design, acquisition of data, revising article critically for important intellectual content, and final approval of the version to be published; Eliad Aviram, contribution to conception and design, acquisition of data, revising article critically for important intellectual content, and final approval of the version to be published; Lior Yehoshua, contribution to conception and design, acquisition of data, revising article critically for important intellectual content, and final approval of the version to be published; Ephraim Eviatar, planner of conception and design, analysis and interpretation of data, revising the article, and final approval of the version to be published.

**Disclosures**

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**References**


