



# The role of osteitis of the lamina papyracea in the formation of subperiosteal orbital abscess in young children



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## ABSTRACT

**Background:** Sub-periosteal orbital abscess (SPOA) typically presents as a collection of pus in the space between the periorbita and the lamina papyracea, adjacent to acute suppurative ethmoiditis. Osteitis of the lamina papyracea may lead to sequestrum formation, with progression of the infectious process to cause suppuration beneath the orbital periosteum.

**Materials and methods:** A case series of children with rhinosinusitis and SPOA admitted to our institute, from January 2005 to December 2011, was carried out. Included were children operated upon, in whom the lamina papyracea was submitted for histological examination, and in which bacteriologic studies were obtained.

**Results:** Nine children with SPOA with a mean age of 5.03 years (range 1–12 years) were included in the present study. In five of them (55.5%), features of osteitis were noted histologically. No pathogens were observed histologically in the sections. Bacteriologic studies revealed *Streptococcus viridans* in four patients, and coagulase negative Staphylococcus in one.

**Conclusion:** SPOA in rhinosinusitis children was associated in our small cohort with high rate of lamina papyracea osteitis. The direct spread through the involved bone was raised as a possible pathophysiology of SPOA formation.

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## 1. Introduction

Rhinosinusitis is a very common disorder affecting children, with an uneventful recovery in most. Serious orbital or intracranial complications may occur, and are usually secondary to acute ethmoid sinusitis; however, antibiotic treatment of rhinosinusitis in general practice does not play a role in preventing complications [1].

Orbital involvement is the most common complication of rhinosinusitis in children and adolescents, and can lead to blindness, intracranial complications, and even death [2]. The subperiosteal orbital abscess (SPOA) classified as Chandler grade 3, typically presents as a collection of pus in the space between the periorbita and the lamina papyracea adjacent to the infected paranasal sinuses. In most cases the ethmoid sinuses will be involved, and more rarely will be the frontal sinus. The SPOA may

deteriorate, with rapid elevation of intraconal pressure that can cause visual impairment. Further intracranial extension of the infection was also reported in up to 15% of cases [3,4].

Multiple theories have been described concerning the pathogenesis of orbital infection in rhinosinusitis, including the direct spread to the orbit through a congenital or acquired defect of the lamina papyracea, infected thrombo-emboli along valveless venous connections, and local thrombophlebitis phenomena [2,5]. Intact bone is a relatively resistant tissue barrier to the spread of infection; however, osteitis of the lamina papyracea, which is assumed to occur in orbital complications secondary to rhinosinusitis, may lead to sequestrum formation and progression of the infectious process through the thin inflamed bone to involve the subperiosteal space. Bony histologic changes underlying the sinus mucosa were first recognized in animal studies of chronic rhinosinusitis (CRS), while limited clinical data studying the clinical picture of osteitis in humans is available.

For the first time in a pediatric population, we reviewed the children who were admitted with medial SPOA, and who underwent surgical drainage of the abscess. The histology of the

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lamina papyracea was evaluated in this group of patients, trying to clarify the pathogenesis of SPOA and allow its proper management.

## 2. Materials and methods

The study was approved by the Institutional Review Board.

A case series of children with rhinosinusitis and medial SPOA admitted to our institute, from January 2005 to December 2011, was carried out. Included were nine cases, all were operated upon, and the lamina papyracea was submitted for histological examination.

### 2.1. Surgical procedure

Surgical intervention was indicated when one of the following criteria existed: deterioration of visual acuity, restricted orbital motility, or persistent fever  $>104^{\circ}\text{F}$  ( $40^{\circ}\text{C}$ ) for more than 48 h despite intravenous antibiotic treatment.

Endoscopic sinus surgery (ESS) was performed using a 4-mm  $0^{\circ}$  and  $30^{\circ}$  telescope, under general anesthesia. The lamina papyracea was completely exposed by removal of the uncinat process, bulla ethmoidalis and anterior and posterior ethmoid cells. First, pus was searched for through possible lamina papyracea dehiscence, and if not found, gentle pressure using a sickle probe over the lamina papyracea was performed to crack the lamina papyracea, and then to remove it for histology examination. External pressure on the orbit continued to help complete evacuation of the abscess until normal tonus of the orbit was achieved and pus was no longer obtained. No drains were left in the surgical field. Pus was collected by a syringe and sent immediately for culture in order to obtain the most accurate results. A small Merocel pack was left in the middle meatus until the following morning [6].

### 2.2. Histopathological assessment

The specimens sent for histological evaluation were formalin-fixed, decalcified and paraffin embedded. Hematoxylin and eosin stain was performed as for routine staining. The osteomyelitis features assessed in these specimens were those of necrotic osteocytes and empty bony lacunae in the lamina papyracea, along with bone destruction and resorption with compensatory new bone formation. Fragments of attached and unattached fibrino-purulent material were also searched for.

### 2.3. Culture and identification of bacteria

Cultures were obtained during surgery from the involved sinuses on the abscess side, and from the drained abscess. The pus was sent to our Microbiology laboratory in sterile transport media for anaerobic and aerobic culture, within half an hour.

In the laboratory, sheep-blood, chocolate and MacConkey's agar plates were inoculated with the sample, for isolation of aerobic organisms.

For the isolation of anaerobes, specimens were plated onto pre-reduced vitamin K and hemin supplemented brucella blood agar. Some of the cultures were also inoculated into thioglycollate broth for enrichment.

Aerobic cultures were incubated at  $36^{\circ}\text{C}$  (chocolate agar plates in an atmosphere containing 5%  $\text{CO}_2$ ) and were examined after 24 and 48 h. Anaerobic cultures were incubated for up to 7 days in an anaerobic system (Sheldon Manufacturing Inc.) with mixed gas (10%  $\text{H}_2$ , 10%  $\text{CO}_2$  and 80%  $\text{N}_2$ ).

The thioglycollate broth was subcultured anaerobically after 3 days.

Aerobic bacteria were identified by standard methods (Lennette). Anaerobic bacteria were identified by methods including

gram staining, use of specific antibiotic identification disks (MICRORINGING<sup>®</sup> AC or AN, Medical Wire & Equipment Co. Ltd.), and the API Rapid ID 32A Identification System (bioMérieux, Marcy L'Etoile, France), utilizing enzymatic tests.

Nitrocefin disks were used to test isolates for the production of  $\beta$ -lactamase.

Bacteriologic studies were analyzed for gram stain, aerobic and anaerobic culture results, single or multiple pathogen culture results and antibiotic sensitivities, if obtained.

Details regarding gender, age and bacteriologic studies were obtained.

## 3. Results

Nine children (5 boys and 4 girls) with SPOA with a mean age of 5.03 years (range 1–12 years) were included in the present study. Bacteriologic studies revealed *Streptococcus viridans* in four cases (44.5%) and *Staphylococcus coagulase negative* in one of them. In five cases no bacterial growth was observed. Involvement of the sinuses with inflammation was observed in the ethmoid sinuses on the CT scan in all cases. During the ESS no cases of lamina papyracea dehiscence were evident.

In five cases (55.5%), features of osteitis were observed histologically. The osteitis features in all specimens were those of bone destruction and resorption, with compensatory new bone formation (Figs. 1 and 2), necrotic osteocytes, and empty bony lacunae in the lamina papyracea (Fig. 3). Fragments of attached and unattached fibrino-purulent material were present.

No pathogens were observed in the sections examined histologically.

The bacteriologic studies' results were positive only in four cases. Bacteriologic studies revealed *Streptococcus viridans* in four patients and coagulase negative *Staphylococcus* in one.

## 4. Discussion

To the best of our knowledge, this is the first study to evaluate bone changes of the lamina papyracea SPOA in young children. Osteitis of the sino-nasal bones is scarcely reported in the literature, and most of the studies report bony inflammatory involvement observed in chronic rhinosinusitis. Another study reporting bone changes in SPOA included older patients with a mean age of 23 years (range 10–35) [7]. Osseous tissue is more vulnerable to bacterial seeding in younger age groups, as a

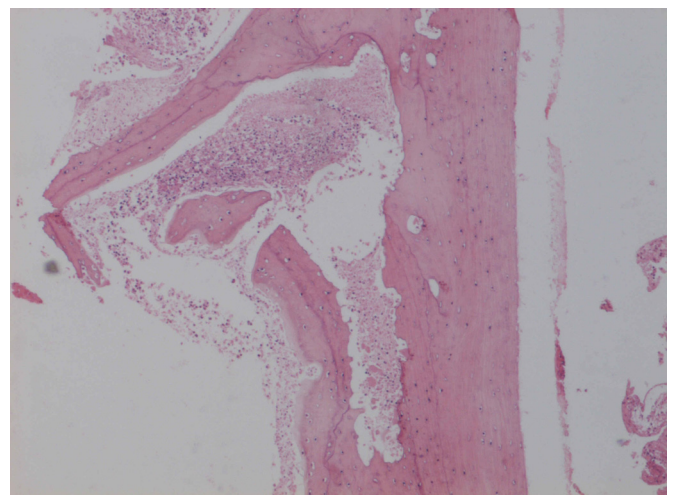


Fig. 1. Histopathology of bone resorption and new bone formation with an inflammatory cell infiltrate (HE, original magnification  $\times 2$ ).

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