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Cerebral actinomycosis in pediatrics: Brain abscesses caused by *Schaalia georgiae*

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ABSTRACT

Actinomycosis is a rare bacterial infection caused by Gram-positive bacilli of the order *Actinomycetales*, which are commensals of the oral cavity. Involvement of the central nervous system is exceptional and is usually associated with hematogenous spread from a dental focus. We report a case of cerebral actinomycosis in an immunocompetent pediatric patient following a tooth extraction.

We present a 14-year-old female patient with partially corrected congenital heart disease who developed multiple brain abscesses from which *Schaalia georgiae* was isolated. Surgical drainage and intravenous antibiotic therapy were administered for six weeks, followed by a prescription for long-term oral doxycycline and outpatient follow-up.

The nonspecific clinical presentation, polymicrobial nature, and difficulty isolating the organism make diagnosis challenging. This case highlights the importance of considering actinomycosis in the differential diagnosis of pediatric brain abscesses and of a timely medical-surgical approach to improve clinical outcomes and reduce sequelae.

Keywords: Actinomyces*; actinomycosis;* Schaalia georgiae*; brain abscess; pediatrics.*

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INTRODUCTION

Actinomyces bacteria are filamentous, branched, pleomorphic, non-spore-forming Gram-positive bacilli that grow under anaerobic or microaerophilic conditions. They are part of the oropharyngeal microbiota, with particularly high concentrations in tonsillar crypts, on the surfaces of decayed teeth, in dental plaque, and in gingival sulci.[1]

Recent polyphylogenetic taxonomic classifications based on 16S rRNA gene sequencing and comprehensive genomic analyses have moved several species previously included in the genus Actinomyces to new genera, including *Bowdeniella*, *Gleimia*, *Pauljensenia*, *Schaalia*, and *Winkia*.[2,3] In human infections, the most common species are *Actinomyces israelii*, *Schaalia meyeri*, and *Schaalia odontolytica*. The microorganism identified in this case, *Schaalia georgiae*, is isolated less frequently.[2,4]

Actinomycosis is a rare condition, with an estimated incidence of approximately 1 case per 300 000 people per year;[5] the pediatric population accounts for about 3 percent.[6] Compromised integrity of the oral mucosa is the primary pathogenic mechanism described.[1,2] The cervicofacial form is the most common clinical manifestation, present in about 50% of cases,[1] whereas involvement of other organs, such as the central nervous system (CNS), is considerably less common.[1,4]

Actinomycosis is confirmed by isolating the microorganism in culture. However, isolating it is particularly difficult, since these microorganisms are frequently involved in polymicrobial infections and require sample processing under strict anaerobic conditions.[1,2,4]

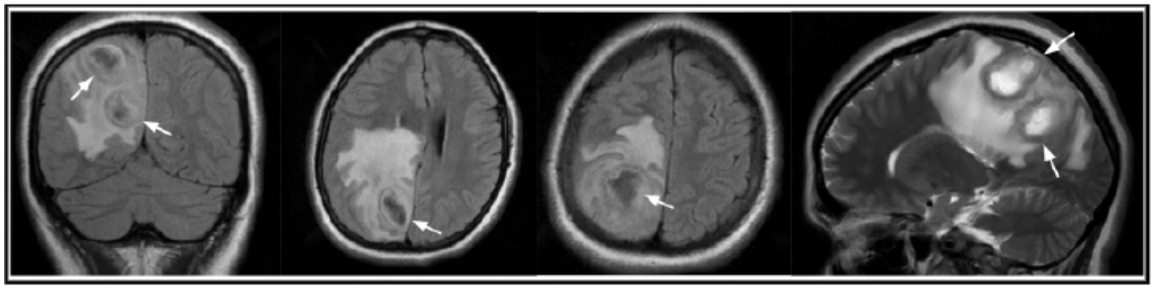
This report describes a rare case of actinomycosis with an aggressive course, of dental origin and likely hematogenous spread, which led to the formation of multiple brain abscesses in an immunocompetent pediatric patient.

CLINICAL CASE

A 14-year-old female patient with tetralogy of Fallot, which was partially corrected with a left subclavian-pulmonary anastomosis at 4 months of age. Her clinical presentation began with fever, frontal headache, and vomiting that had persisted for 7 days. She subsequently developed left brachiocrural hemiparesis. Of note in her medical history, she had undergone a tooth extraction 2 weeks before the onset of symptoms, for which she received antibiotic prophylaxis with oral amoxicillin-clavulanate for 24 hours. On admission, she had a continuous systolic-diastolic base murmur and the previously described neurological focus; she was alert, responsive, and oriented, with no other significant findings. At the referring hospital, a central nervous system (CNS) magnetic resonance imaging (MRI) scan revealed two lesions consistent with cerebral abscesses in the right temporoparieto-occipital region, with severe vasogenic edema, midline shift, and ventricular collapse (*Figure 1*). Blood cultures were negative, and an echocardiogram showed no evidence of vegetations. The patient was admitted to our institution after 5 days of treatment with meropenem, vancomycin, and intravenous dexamethasone; the antibiotic regimen was changed to cefotaxime, metronidazole, and vancomycin, and neurosurgery was scheduled.

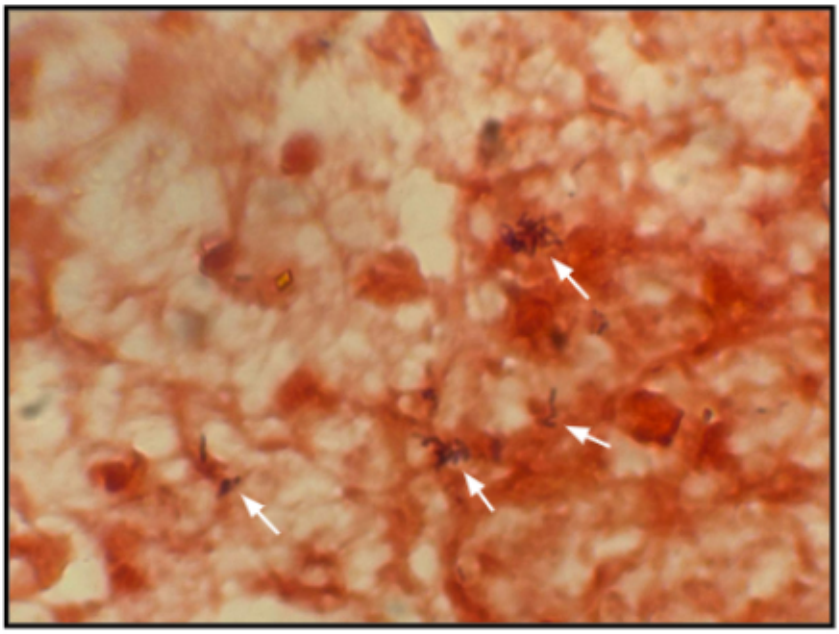
About 13 days after symptom onset, the

Figure 1. Contrast-enhanced brain MRI performed at the onset of symptoms



Post-contrast T1-weighted and T2-weighted images. Multiple lesions with peripheral enhancement, consistent with cerebral abscesses (arrows), are observed in the right temporoparieto-occipital region, associated with vasogenic edema and a mass effect with ventricular collapse and midline shift.

Figure 2. Gram stain of purulent material obtained from the brain abscess



Filamentous and branched Gram-positive bacilli are observed (arrows).

abscesses were completely drained, and the capsule was completely resected. The microbiology laboratory received purulent material, and Gram staining revealed Gram-positive, filamentous, branched bacilli (*Figure 2*). Following prolonged incubation under strictly anaerobic conditions, colonies suggestive of the order *Actinomycetales* developed. The isolate was referred to and confirmed at the reference center (INEI-ANLIS Dr. Carlos G. Malbrán) using MALDI-TOF mass spectrometry, where it was identified as *Schaalia georgiae* (formerly *Actinomyces georgiae*). The definitive result was obtained 14 days after the sample was received, and the minimum inhibitory concentration (MIC) for cefotaxime (0.064 µg/ml) was determined using gradient strips.

During the illness, the left-sided neurological deficit improved, but right upper- and lower-limb hemiparesis developed on the sixth postoperative day. A new CNS MRI (*Figure 3*) identified a new contralateral lesion not detected in the initial workup. The differential diagnoses considered were a new abscess in formation or a lesion secondary to bleeding/ischemia as a post-neurosurgical complication. Blood cultures and an echocardiogram were repeated, both negative. Since the lesion was not surgically accessible, follow-up continued with imaging studies; the condition progressed toward a chronic state in subsequent follow-up visits (*Figure 4*).

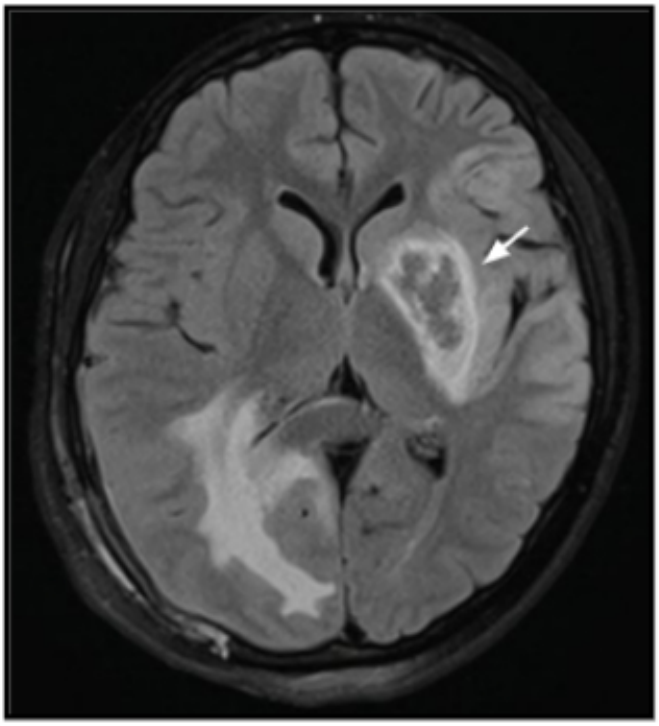
She received intravenous antimicrobial therapy with cefotaxime and metronidazole. At 3 weeks, she developed a hypersensitivity reaction to beta-lactam antibiotics, so clinicians switched to linezolid, which she tolerated well. She completed a total of 6 weeks of intravenous treatment following surgical drainage, with a favorable neurological outcome. The patient returned to her home province on a regimen of long-term suppressive therapy with oral doxycycline for cerebral actinomycosis.

Currently, she has no neurological sequelae. She underwent definitive surgical correction of her underlying heart condition. The Infectious Diseases and Pediatric Cardiology departments continue to monitor her, and she is receiving antimicrobial treatment.

DISCUSSION

CNS infection caused by bacteria of the genus *Actinomyces* and related species occurs in less than 5% of cases of actinomycosis.[4,5] A cerebral abscess is the most common presentation (55%), usually solitary (75%) and located in the frontal and parietal lobes. Other manifestations, such

Figure 3. Contrast-enhanced brain MRI, FLAIR sequence, performed on the sixth day after surgical drainage



The drained lesions (right parieto-occipital region) improve, and a new contralateral lesion appears with peripheral enhancement and a necrotic center (arrow).

as meningitis and venous sinus thrombosis, have been described. The reported mortality rate in adults is 11%, and the rate of neurological sequelae is 22%.[4]

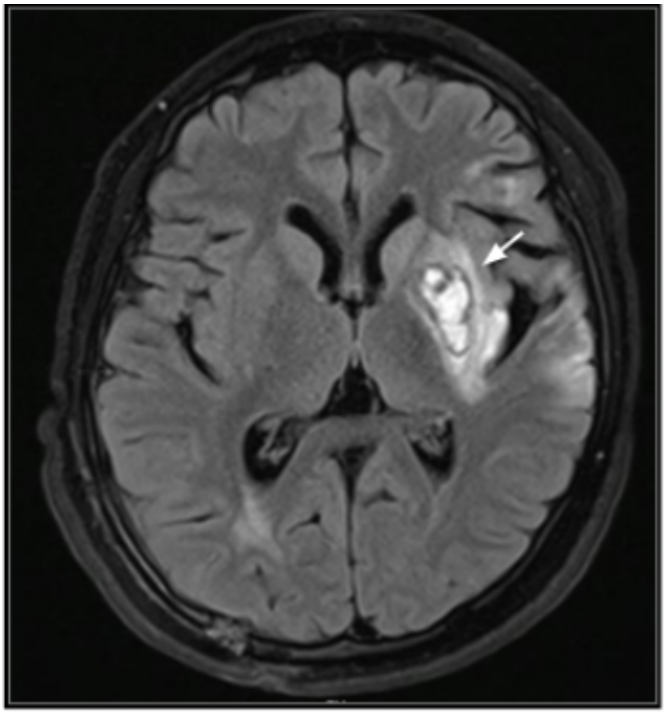
Clinically and radiologically, brain abscesses caused by *Actinomyces* are indistinguishable from those caused by other bacterial pathogens. The most common symptoms are headache and focal neurological signs,[1,4] followed by fever (43%).[4] On MRI, they are typically described as lesions with ring-like enhancement and thickened walls, associated with significant vasogenic edema and perilesional vascular congestion.[1,4,5] Hematogenous spread from dental or pulmonary foci is one of the pathogenic mechanisms described for CNS involvement.[1,4,7] In this context, a history of recent dental procedures, periodontal disease, poor oral hygiene, or deep dental infections is particularly important in establishing the suspected cause, especially when associated with factors that promote bacteremia, such as cyanotic heart disease, which has been described as a possible risk factor for the development of *Actinomyces* brain abscesses.[4,7]

A notable feature of this case was the isolation and accurate identification of *Schaalia georgiae*. Although culture is still considered the gold standard, the recovery rate for species of the genus *Actinomyces* and related genera is extremely low[1,2] due to their sensitivity to oxygen and the prior administration of empirical antibiotic therapy. In this case, optimizing culture conditions through prolonged anaerobic incubation, combined with MALDI-TOF mass spectrometry, overcame traditional diagnostic limitations and corrected previous taxonomic assignments.

In addition, *Actinomyces* is often involved in polymicrobial infections.[1,2] Among the most frequently reported co-pathogens are species of *Bacteroides*, *Fusobacterium*, *Propionibacterium*, and *Streptococcus*.[2] This combination could explain the particularly aggressive course of the infection observed in our patient, which is uncommon in infections caused exclusively by *Actinomycetales*. For this reason, even after microbiological confirmation, we continued the combination antibiotic regimen to cover other oral cavity microorganisms—both aerobic and anaerobic.

Histologically, clusters of filamentous

Figure 4. Contrast-enhanced brain MRI performed 21 days after surgical drainage, FLAIR sequence



The left lesion (arrow) appears smaller than in the previous image (Figure 3), with a smaller halo of perilesional edema and central necrotic changes, consistent with progression toward a chronic state.

bacteria called sulfur granules characterize actinomycosis, although their absence does not rule out the diagnosis and their presence is not pathognomonic. The differential diagnoses for cerebral actinomycosis include nocardiosis, tuberculosis, fungal infections, and neoplasms. Acid-fast staining allows for the differentiation of *Nocardia* from *Actinomyces*.[1,5]

The standard treatment for actinomycosis consists of a prolonged course of intravenous penicillin (2 to 6 weeks) followed by 6 to 12 months of oral treatment. In patients with a beta-lactam allergy, clinicians have used erythromycin, tetracyclines, doxycycline, minocycline, and clindamycin as alternatives.[1,5,6] Surgical treatment may be indicated for accessible brain abscesses for diagnostic and therapeutic purposes,[4,8] and has been associated with lower mortality.[4] Our patient received surgical drainage plus antimicrobials with adequate penetration into the CNS and a spectrum effective against pathogens of the oral cavity.

We emphasize the importance of considering actinomycosis as a differential diagnosis for pediatric brain abscesses and the need for prolonged antimicrobial treatment and long-term interdisciplinary follow-up. ■

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