Pyogenic Brain Abscess Caused by *Streptococcus pneumoniae*: Case Report and Review

Elizabeth Grigoriadis and Wayne L. Gold

While *Streptococcus pneumoniae* is the most common cause of bacterial meningitis in adults, cases of pneumococcal brain abscess have rarely been reported. We describe a case of otogenic brain abscess caused by *S. pneumoniae* that developed in a patient who was receiving ciprofloxacin for the empirical treatment of otitis media. We also review 23 additional cases of pyogenic brain abscess caused by *S. pneumoniae* that have previously been reported. The development of a pneumococcal brain abscess was associated with a contiguous intracranial focus of infection in 50% of cases. The majority of patients presented with headache (81%) and focal neurological deficits (86%). However, the classic triad of headache, fever, and focal neurological deficits was present in only 24% of patients. The mortality rate for patients with brain abscess caused by *S. pneumoniae* was 35%; persistent neurological deficits were documented in 40% of patients who survived.

*Streptococcus pneumoniae* is an important human bacterial pathogen. Infections caused by this organism include pneumonia, meningitis, sinusitis, and acute otitis media. *S. pneumoniae* is the most common bacterial etiology of community-acquired pneumonia, which may be complicated by bacteremia in up to 25% of cases. In the preantibiotic era, hematogenous spread from a primary pulmonary site of infection was responsible for the development of secondary supplicative complications, including infective endocarditis, pericarditis, septic arthritis, osteomyelitis, and panniculitis. At the present time, however, extrapulmonary sites of pneumococcal infection, excluding cases of pneumococcal meningitis, are rarely reported. While *S. pneumoniae* is the most common cause of bacterial meningitis in adults, this organism has rarely been reported as a cause of pyogenic brain abscess [1]. We report a case of brain abscess caused by *S. pneumoniae* and review the clinical features, predisposing factors, treatments, and outcomes of 23 previously reported cases of pneumococcal brain abscess.

Methods

Case definition. A case of pneumococcal brain abscess was defined when (1) culture of a brain biopsy or aspirate specimen yielded growth of *S. pneumoniae*; (2) latex agglutination assay was positive for pneumococcal capsular antigens in a brain biopsy or aspirate specimen; or (3) CT and/or MRI studies demonstrated lesions compatible with the radiological features of a brain abscess, in a patient for whom culture of a normally sterile specimen (blood, CSF, or pleural fluid) yielded *S. pneumoniae*.

Case identification. Cases of brain abscess caused by *S. pneumoniae* were identified from two sources. The first source was the discharge records of The Toronto Hospital from January 1983 to August 1996. The Toronto Hospital is a university-affiliated tertiary-care facility in Toronto, Ontario, Canada. The second source included previously reported cases of pneumococcal brain abscess identified through a MEDLINE search of articles published from January 1966 to August 1996. The key words *Streptococcus pneumoniae*, pneumococcal infections, and brain abscess were used in the search. Secondary references were also reviewed to identify all cases of pneumococcal brain abscess that have been reported since 1900. Patient demographics, risk factors for pneumococcal infection, most likely mechanism of infection, details of microbiological and radiological investigations, therapies, and outcomes were recorded for all cases.

Case Report

A 58-year-old right-handed man was transferred to The Toronto Hospital for the investigation and management of a presumed right-temporal-lobe brain abscess. His medical history was significant for recurrent right-middle-ear infections and hypertension. In addition, 3 months before admission, he had undergone extraction of a right molar for management of a dental abscess.

Three weeks before admission, right-sided otitis media was clinically diagnosed, for which a course of oral ciprofloxacin was prescribed. One week later, his clinical course was complicated by the development of night sweats, headache, nausea, vomiting, and difficulties with speech. At the time of admission, the patient was somnolent but arousable. He was afebrile. There was no nuchal rigidity.

Examination of the head and neck revealed an inflamed right tympanic membrane; there was no discharge from the ear.
Neurological examination revealed left-sided hemisensory neglect. There was an upgoing left plantar response. Funduscopic examination demonstrated blurring of the medial aspect of the right-optic-disc margin, and examination of the visual fields showed a left homonymous hemianopsia. There was bilateral conductive hearing loss.

A complete blood cell count revealed a normal hemoglobin concentration; the WBC count was $10.6 \times 10^9/L$ (granulocyte count, $8.3 \times 10^9/L$). A CT scan of the head showed a 2-cm solitary ring-enhancing lesion in the right temporoparietal region with surrounding edema, resulting in a midline shift. There were radiological features of mastoiditis.

The patient underwent burr-hole aspiration of the right-temporal-lobe lesion, which yielded 9 mL of purulent fluid. Gram staining of the aspirate specimen revealed many polymorphonuclear leukocytes and a few gram-positive cocci. Empirical antimicrobial therapy was initiated with parenteral cloux-acillin, cefotaxime, and metronidazole. Two days following admission, the aspirate specimen yielded a pure growth of S. pneumoniae, which was susceptible to penicillin. Treatment was continued with penicillin ($4 \times 10^6$ units iv q6h) and metronidazole ($500 \text{ mg po q8h}$).

Anaerobic, fungal, and mycobacterial cultures of the aspirate specimen yielded no growth. Aspiration of the abscess was repeated on the eighth day and the twenty-second day of therapy; cultures of these specimens were negative. Parenteral antibiotic therapy was continued for a total of 4 weeks and was followed by an 8-week course of amoxicillin ($500 \text{ mg po q8h}$) and metronidazole ($500 \text{ mg po q8h}$). At the completion of therapy, another CT scan of the head showed near-complete resolution of the abscess. The patient remains well more than 2 years following the discontinuation of therapy; he has no residual neurological deficits.

Results

A review of the discharge records of The Toronto Hospital from January 1983 to August 1996 identified one patient with the diagnosis of brain abscess caused by S. pneumoniae. A review of the English-language literature published from 1900 to 1996 identified an additional 23 previously reported cases of pneumococcal brain abscess for which there were detailed clinical and microbiological data [2–19]. The clinical features and outcomes of these 24 cases of pneumococcal brain abscess are summarized in table 1. There were fourteen males and six females; the sex was not specified in four of the cases. The average age of the patients was 23 years (range, 6 weeks to 63 years).

Predisposing factors. Four of the 24 cases (17%) had risk factors that are associated with an increased risk of invasive pneumococcal infection: alcoholism (1), diabetes mellitus (2), and infection with HIV (1). An additional patient had congenital cyanotic heart disease, a condition that is associated with an increased risk for the development of pyogenic brain abscess. Twelve (50%) of the cases of pneumococcal brain abscess resulted from contiguous spread from an intracranial focus of infection. Primary intracranial sites of infection included otitis media/mastoiditis (8), sinusitis (3), and meningitis (1). Three (13%) of cases were the result of hematogenous spread from an intrathoracic focus of infection: empyema (2) and pulmonary gangrene (1). In five patients (21%), pneumococcal brain abscess occurred as a complication of penetrating head trauma or following a neurosurgical procedure. Four cases (17%) were classified as cryptogenic pneumococcal brain abscess (no obvious primary source of infection).

Clinical presentation. Details of the presenting signs and symptoms were recorded for 21 of the 24 cases. At the time of presentation, 18 (86%) of the 21 patients had focal neurological deficits. Headache was reported by 17 patients (81%), while fever was recorded for only six (29%) of the patients. The classic triad of fever, headache, and focal neurological deficits was present in only five (24%) of the patients. Alteration in level of consciousness was recorded for 12 patients (57%). Signs and/or symptoms of raised intracranial pressure, including nausea, vomiting, and papilledema, were present in 17 patients (81%). One patient (5%) had hydrocephalus. Four (19%) of the 21 patients had seizures.

Sites of infection. In decreasing order of involvement, the sites of brain abscess included the frontal lobe (33%), the temporal lobe (24%), the parietal lobe (18%), the cerebellum (18%), and the occipital lobe (6%). Seven patients (30%) were documented as having a solitary brain abscess that involved more than one lobe, while three patients (13%) were documented as having multiple brain abscesses.

Laboratory investigations. The results of a peripheral WBC count were available in eight cases (mean, $13.7 \times 10^9/L$; range, 4.7–30.2 $\times 10^9/L$). In six of the eight cases (75%), the WBC count was $>10.0 \times 10^9/L$. Lumbar puncture was performed in 11 patients. The mean CSF WBC count was $134 \times 10^9/L$ (range, 4–421 $\times 10^9/L$). The mean CSF protein concentration was 0.97 g/L (range, 0.40–2.52 g/L).

Microbiology. The diagnosis of pneumococcal brain abscess was based on the following microbiological findings: culture of a brain aspirate specimen yielded growth of S. pneumoniae (19); gram staining of a brain aspirate specimen revealed gram-positive diplococci (2); culture of CSF yielded growth of S. pneumoniae following rupture of the abscess during surgical excision (1); and a latex agglutination assay was positive for pneumococcal capsular antigen in a brain aspirate specimen (1). One patient (case 9) was stated to have “pneumococcal pyocephalus”; however, details of microbiological investigations were not provided. In four (17%) of the cases, the brain abscess had a polymicrobial etiology. In addition to S. pneumoniae, organisms that were cultured from the biopsy specimens included Staphylococcus aureus (2), gram-negative bacilli (1), and Haemophilus influenzae (1).

Treatments and outcomes. Two cases of pneumococcal brain abscess were diagnosed after death. Details regarding the treatment were not available for two additional cases. Drainage
<table>
<thead>
<tr>
<th>Case no./reference, year of publication</th>
<th>Patient’s age (y)/sex</th>
<th>Mechanism of infection</th>
<th>Presenting signs and symptoms</th>
<th>Site of abscess</th>
<th>Treatment</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2 1938</td>
<td>6/F</td>
<td>Posttraumatic</td>
<td>HA, V, P, FND, meningsismus, fever, irritability</td>
<td>Frontal lobe</td>
<td>Marsupialization of abscess cavity; sulfanilamide</td>
<td>Died</td>
</tr>
<tr>
<td>2/3 1938</td>
<td>14/M</td>
<td>Contiguous spread (otitis media)</td>
<td>HA, V, P, FND, meningsismus</td>
<td>Cerebellum</td>
<td>Marsupialization of abscess cavity</td>
<td>Survived; persistent neurological deficits</td>
</tr>
<tr>
<td>3/3 1938</td>
<td>40/M</td>
<td>Hematogenous spread (empyema)</td>
<td>HA, P, FND, seizures</td>
<td>Parietal lobe, cerebellum</td>
<td>Aspiration</td>
<td>Died</td>
</tr>
<tr>
<td>4/4 1940</td>
<td>52/M</td>
<td>Postoperative</td>
<td>P, FND, meningsismus, iLOC</td>
<td>Frontal lobe, parietal lobe, temporal lobe</td>
<td>Marsupialization of abscess cavity</td>
<td>Survived; persistent neurological deficits</td>
</tr>
<tr>
<td>5/5 1945</td>
<td>NA</td>
<td>Posttraumatic</td>
<td>Meningismus, FND, seizures, iLOC</td>
<td>Frontal lobe</td>
<td>No treatment</td>
<td>Died</td>
</tr>
<tr>
<td>6/6 1946</td>
<td>32/M</td>
<td>Hematogenous spread (empyema)</td>
<td>Meningismus, FND, seizures, iLOC</td>
<td>Temporal lobe, occipital lobe</td>
<td>Aspiration; excision; irrigation of abscess cavity with penicillin and V187; penicillin (100,000 U iv and im × 14 d); penicillin (10,000 U intrathecally)</td>
<td>Survived; persistent neurological deficits</td>
</tr>
<tr>
<td>7/5 1946</td>
<td>46/M</td>
<td>Hematogenous spread (pulmonary gangrene)</td>
<td>HA, P, FND</td>
<td>Parietal lobe, temporal lobe, occipital lobe</td>
<td>Excision; irrigation of abscess cavity with penicillin; penicillin (80,000 U iv and im × 4 d); methylazine (12 g po × 4 d); sulfanilamide; sulfapyridine (po × 16 d)</td>
<td>Survived; persistent neurological deficits</td>
</tr>
<tr>
<td>8/7 1946</td>
<td>12/F</td>
<td>Contiguous spread (otitis media)</td>
<td>HA, V, P, fever, FND, meningsismus, iLOC</td>
<td>Cerebellum</td>
<td>Aspiration; excision; irrigation of abscess cavity with penicillin</td>
<td>Survived; complete neurological recovery</td>
</tr>
<tr>
<td>9/8 1948</td>
<td>16/F</td>
<td>Contiguous spread (otitis media)</td>
<td>HA, V, P, FND, meningsismus, iLOC</td>
<td>Cerebellum</td>
<td>Aspiration; sulfonamides (po × 19 d)</td>
<td>Survived; complete neurological recovery</td>
</tr>
<tr>
<td>10/8 1948</td>
<td>12/F</td>
<td>Contiguous spread (otitis media)</td>
<td>HA, V, P, FND, meningsismus, iLOC</td>
<td>Cerebellum</td>
<td>Excision; sulfonamides (po, iv, im)</td>
<td>Died</td>
</tr>
<tr>
<td>11/9 1950</td>
<td>8/M</td>
<td>Contiguous spread (otitis media)</td>
<td>HA, V, P, FND, iLOC</td>
<td>Temporal lobe</td>
<td>Aspiration; excision</td>
<td>Survived; persistent neurological deficits</td>
</tr>
<tr>
<td>12/9 1950</td>
<td>49/M</td>
<td>Contiguous spread (sinusitis)</td>
<td>HA, FND, confusion, iLOC</td>
<td>Frontal lobe</td>
<td>Repeated aspiration; excision; irrigation of abscess cavity with penicillin</td>
<td>Survived; complete neurological recovery</td>
</tr>
<tr>
<td>13/10 1950</td>
<td>NA</td>
<td>Posttraumatic</td>
<td>NA</td>
<td>Parietal lobe</td>
<td>Marsupialization of abscess cavity; penicillin</td>
<td>Died</td>
</tr>
<tr>
<td>14/11 1961</td>
<td>2/M</td>
<td>Cryptogenic</td>
<td>V, P, FND, irritability, seizures, iLOC</td>
<td>Temporal lobe, parietal lobe</td>
<td>Aspiration; excision; antibiotic therapy (agent not specified)</td>
<td>Died</td>
</tr>
<tr>
<td>15/12 1962</td>
<td>5/F</td>
<td>Posttraumatic (skull fracture)</td>
<td>HA, V, FND, seizures, iLOC</td>
<td>Frontal lobe</td>
<td>Aspiration</td>
<td>Survived; complete neurological recovery</td>
</tr>
<tr>
<td>16/12 1962</td>
<td>11/NA</td>
<td>Cryptogenic</td>
<td>HA, V, P</td>
<td>Frontal lobe</td>
<td>Cerebellum</td>
<td>Aspiration</td>
</tr>
<tr>
<td>17/13 1966</td>
<td>6/M</td>
<td>Cryptogenic</td>
<td>HA, V, P</td>
<td>Frontal lobe</td>
<td>Cerebellum</td>
<td>Excision</td>
</tr>
<tr>
<td>18/14 1967</td>
<td>34/NA</td>
<td>Cryptogenic</td>
<td>HA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>19/15 1970</td>
<td>6 w/M</td>
<td>Cryptogenic</td>
<td>Fever, irritability, poor feeding, hydrocephalus</td>
<td>Bifrontal</td>
<td>Aspiration, irrigation of abscess cavity with penicillin</td>
<td>Survived; hydrocephalus</td>
</tr>
<tr>
<td>20/16 1970</td>
<td>63/F</td>
<td>Contiguous spread (otitis media)</td>
<td>HA, FND, N, meningsismus, fever, iLOC</td>
<td>Temporal lobe</td>
<td>None</td>
<td>Died</td>
</tr>
<tr>
<td>21/17 1985</td>
<td>3 mo/M</td>
<td>Contiguous spread (meningsis)</td>
<td>NA</td>
<td>Frontal lobe</td>
<td>NA</td>
<td>Died</td>
</tr>
<tr>
<td>22/18 1992</td>
<td>37/M</td>
<td>Cryptogenic</td>
<td>HA, V, P, FND, meningsismus, fever, iLOC</td>
<td>Frontal lobe, temporal lobe</td>
<td>Stereotactic drainage; penicillin (24 × 10^6 U iv × 42 d)</td>
<td>Survived; persistent neurological deficits</td>
</tr>
<tr>
<td>23/19 1994</td>
<td>9/M</td>
<td>Cryptogenic</td>
<td>HA, V, meningsismus, fever, FND</td>
<td>Frontal lobe</td>
<td>Stereotactic drainage; antibiotics (agents not specified)</td>
<td>Survived; complete neurological recovery</td>
</tr>
<tr>
<td>24/PR 1997</td>
<td>58/M</td>
<td>Contiguous spread (otitis media)</td>
<td>HA, V, P, FND</td>
<td>Temporal lobe, parietal lobe</td>
<td>Aspiration; penicillin (16 × 10^6 U iv) and metronidazole (1,500 mg po) × 28 d; amoxicillin (1,500 mg po) and metronidazole (1,500 mg po) × 56 d</td>
<td>Survived; complete neurological recovery</td>
</tr>
</tbody>
</table>

**NOTE:** FND = focal neurological deficits; HA = headache; iLOC = decreased level of consciousness; NA = not available; P = papilledema; PR = present report; V = vomiting.
procedures were performed in the remaining 20 cases: burr-hole aspiration (6); aspiration followed by surgical excision (5); primary surgical excision (3); marsupialization of the abscess (4); and stereotactic drainage of the abscess under ultrasonicographic guidance (2).

Antimicrobial treatment was administered to 13 patients, but details of the therapy were provided for only 11 of these patients. Seven patients received penicillin, with or without the addition of another antimicrobial agent; five patients were treated with a sulfa antimicrobial agent. Combination therapy was administered to 3 patients: penicillin and a sulfa agent (1); penicillin, methylidiazine, and an investigational antimicrobial agent, V187, which was reported to have activity against anaerobic bacteria (1); and penicillin and metronidazole (1).

The clinical outcomes were available for 23 of the 24 cases. Eight (35%) of the 23 cases had a fatal outcome. Four (33%) of the 12 cases reported in the preantibiotic era (prior to 1945) had a fatal outcome, and 4 (36%) of the 11 cases reported after 1945 had a fatal outcome. In five of the fatal cases, mortality was attributable to the development of postoperative meningitis or ventriculitis that occurred as a result of rupture of the abscess. Persistent neurological deficits in six (40%) of the 15 patients who survived were documented.

Discussion

Although S. pneumoniae is the most common cause of bacterial meningitis in adults [1], detailed clinical and microbiological descriptions of S. pneumoniae as a cause of pyogenic brain abscess are rare. The majority of cases of pneumococcal brain abscess were reported prior to 1945—in the preantibiotic era. In 1937, Mayfield and Spurling [20] reported S. pneumoniae as the etiologic agent in 18.8% of cases of pyogenic brain abscess. In 1943, McFarlan [21] identified S. pneumoniae in 12.5% of brain abscess specimens that were submitted for culture, and in 1957, Loeser and Scheinberg [22] cultured pneumococci from 10.1% of brain abscess specimens.

In contrast to earlier reports, investigators in recent series of pyogenic brain abscess rarely have reported S. pneumoniae as a cause of this infection. Currently, this organism is estimated to cause fewer than 1% of all cases of pyogenic brain abscess [23–29]. In addition to the present report, only two other cases of pneumococcal brain abscess have been reported since 1970 [12, 19]. Consequently, there are few detailed case descriptions in the English-language literature of pyogenic brain abscess caused by S. pneumoniae.

The most common site of pneumococcal brain abscess was the frontal lobe, which was followed in decreasing frequency of involvement by the temporal lobe, the parietal lobe, and the cerebellum. This distribution of lesions is consistent with the locations of pyogenic brain abscess caused by other microorganisms. Despite a reported decline in the development of pyogenic brain abscess as a complication of otitis media/mastoiditis [22, 30, 31], spread from a contiguous intracranial focus of infection still remains the most common route of this infection [26, 32–35]. Approximately 33% of cases of brain abscess caused by S. pneumoniae were associated with otitis media/mastoiditis. Contiguous spread from a primary intracranial focus of infection was the most likely mechanism of infection in 50% of the cases. Other primary intracranial sites of infection included sinusitis and meningitis. The distribution of brain abscess lesions is often reflective of the predisposing, contiguous foci of infection. The eight cases of otogenic brain abscess were located in the temporal lobe (3) and the cerebellum (5).

In the present review, focal neurological deficits were the most common presenting complaint. Fever was present in only one-third of cases. The classic triad of headache, fever, and focal neurological deficits was present in only 24% of cases. These findings are consistent with the clinical presentations of pyogenic brain abscess caused by other microorganisms. Pyogenic brain abscess most frequently presents with symptoms of an expanding intracranial lesion rather than with signs or symptoms suggestive of infection.

The mortality rate of 35% for cases of pneumococcal brain abscess is comparable to the mortality rates (30%–70%) that have been reported in reviews of pyogenic brain abscess caused by other bacteria [22, 33–38]. Previous authors have observed that the specific infecting organism seems to have little influence on mortality [39]. Recent reviews of pyogenic brain abscess have reported an apparent overall improvement in survival rates. The improved clinical outcomes are likely attributable to the widespread availability of effective antimicrobial agents and to more prompt diagnosis, which has been made possible by the advent of modern diagnostic imaging [23, 36].

S. pneumoniae is rarely the cause of pyogenic brain abscess. In a significant proportion of cases, pneumococcal brain abscess is associated with contiguous spread from a primary intracranial focus of infection. This mechanism of infection is similar to the pathogenesis of pyogenic brain abscess caused by other microorganisms. Moreover, the clinical features of pneumococcal brain abscess do not differentiate these infections from cases of pyogenic brain abscess caused by other microorganisms. This observation highlights the importance of obtaining brain aspiration and/or biopsy specimens in order to permit a specific microbiological diagnosis.

Identification of the causative organism and determination of the antibiotic susceptibility pattern are necessary to permit the administration of appropriate antimicrobial therapy. Although penicillin and a third-generation cephalosporin are included in most empirical antimicrobial regimens for the treatment of pyogenic brain abscess of sinus or otitic origin, the increasing incidence of penicillin and cephalosporin resistance among pneumococcal isolates [40] further emphasizes the need to identify the specific causative agent.

This report also documents the development of a potentially life-threatening infection caused by S. pneumoniae during the empirical treatment of otitis media with ciprofloxacin. Previously, life-threatening pneumococcal infections, including...
bacteremia and meningitis, have been reported as developing in patients receiving ciprofloxacin for the treatment of both otitis media and pneumonia caused by *S. pneumoniae* [41–44]. This antimicrobial agent is not recommended as the first-line drug for empirical treatment of otitis media or other upper or lower respiratory tract infections. The MIC90 values of ciprofloxacin for *S. pneumoniae* range from 1 μg/mL to 4 μg/mL, whereas the maximum serum level of ciprofloxacin achieved after a 500-mg oral dose is ~2.5 μg/mL [42]. The role of fluoroquinolones in the management of upper and lower respiratory tract infections should be limited to the treatment of culture-proven infections caused by susceptible microorganisms.

**References**