

# Brain abscess in Korean children: A 15-year single center study

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**Purpose:** A brain abscess is a serious disease of the central nerve system. We conducted this study to summarize the clinical manifestations and outcomes of brain abscesses.

**Methods:** A retrospective chart review of pediatric patients diagnosed with brain abscesses from November 1994 to June 2009 was performed at Samsung Medical Center, Seoul, Korea.

**Results:** Twenty-five patients were included in this study. On average, 1.67 cases per year were identified and the median age was 4.3 years. The common presenting clinical manifestations were fever (18/25, 72%), seizure (12/25, 48%), altered mental status (11/25, 44%), and signs of increased intracranial pressure (9/25, 36%). A total of 14 (56%) patients had underlying illnesses, with congenital heart disease (8/25, 32%) as the most common cause. Predisposing factors were identified in 15 patients (60%). The common predisposing factors were otogenic infection (3/25, 12%) and penetrating head trauma (3/25, 12%). Causative organisms were identified in 64% of patients (16/25). The causative agents were *S. intermedius* (n=3), *S. aureus* (n=3), *S. pneumoniae* (n=1), Group B streptococcus (n=2), *E. coli* (n=1), *P. aeruginosa* (n=1), and suspected fungal infection (n=5). Seven patients received medical treatment only while the other 18 patients also required surgical intervention. The overall fatality rate was 16% and 20% of patients had neurologic sequelae. There was no statistical association between outcomes and the factors studied.

**Conclusion:** Although uncommon, a brain abscess is a serious disease. A high level of suspicion is very important for early diagnosis and to prevent serious consequences.

**Key words:** Brain, Abscess, Child, Korea

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## Introduction

A brain abscess is a focal collection of infectious material within

the brain, which can arise as a complication from a variety of causes including infection, trauma, and surgery. A wide variety of organisms (bacteria, fungi, protozoa, and parasites) can cause abscess

formation. Brain abscesses occur relatively infrequently because of the abundant blood supply to the brain and the protection of the brain by the blood-brain barrier. In the pre-antibiotics era when medicines with good central nervous system (CNS) penetration were not available, brain abscesses were almost uniformly lethal<sup>1)</sup>. Despite the major advances in neuroimaging and the increased availability of potent antibiotics and neurosurgical intervention, the incidence of brain abscesses has not changed much. Brain abscesses still have high rates of neurologic impairment and fatality<sup>2)</sup>. While a number of reports have reviewed brain abscesses in adult populations, only a few comprehensive reports on long follow-ups of pediatric cases are available<sup>2-8)</sup>. In this study, we analyzed data from 25 patients with brain abscesses and we describe the clinical features of these brain abscesses.

## Materials and methods

Pediatric patients less than 19 years old who were diagnosed with a brain abscess at Samsung Medical Center, Seoul, Korea from November 1994 through June 2009 were included. We searched all the patients whose diagnosis at discharge was brain abscess(es) using Samsung Medical Information System (SMIS) and only included cases with radiological evidence; 21 patients had brain parenchymal abscesses, 3 patients had a subdural abscess, and 1 patient had an epidural abscess. Clinical data (clinical manifestations, initial laboratory findings, causative organisms, characteristics of abscesses, treatment modalities, and outcomes) were collected based on retrospective chart reviews. Statistical analysis, such as univariate analysis, Mann-Whitney test, Fisher's exact test, was performed to evaluate association between outcomes and the factors studied.

## Results

### 1. Patient characteristics

A total of 25 pediatric patients were diagnosed with one or more brain abscesses during 14.7 consecutive years, an average of 1.67 cases per year. Fourteen patients were male and 11 patients were female (ratio 1.3:1). The median age was 4.3 years (range, 0.1-18.9 years), and the abscesses occurred most commonly in patients younger than 2 years of age, including 1 neonate (11/25, 44%). Five of these 11 patients (45%) were born prematurely (< 37 weeks gestational age).

Underlying diseases and predisposing factors are listed in Table 1. Fourteen patients (56%) presented with known underlying medical conditions: congenital heart disease (CHD,

n=8), immunodeficiency (n=3) due to acute myeloblastic leukemia (AML), myelodysplastic syndrome (MDS) and agammaglobulinaemia, and suspected arterial venous malformation (n=1). In patients younger than 2 years old (n=11), prematurity was also considered to be an underlying medical condition (n=5). Two patients had both prematurity and CHD and one patient had MDS and CHD. Predisposing factors were identified in 15 patients (15/25, 60%). The common predisposing factors were otogenic infection (n=3) and penetrating head trauma (n=3) followed by preceding meningitis (n=2), neurosurgical procedures (n=2), endocarditis (n=2), ventriculoperitoneal shunts (n=2), and poor oral hygiene with lymphangioma at the tongue base (n=1).

### 2. Clinical presentation

The most common presenting symptom was fever (17/25, 68%). The median body temperature at diagnosis was 38.5°C (range, 36.3-41°C). Twelve patients (48%) had seizures (generalized or partial). Altered mental status (ranging from drowsy to coma) was observed in 12 patients (48%): 7 patients were drowsy, 2 were in a stupor, and 3 were in a semicomma. One patient's mental status could not be assessed due to deep sedation. The median interval between symptom onset and diagnosis by imaging studies was 11 days in 23 patients (range, 1-119 days). Two patients did not have any symptoms. One patient had the longest time delay of 119 days until diagnosis. This patient was a 9 month-old female who had been born prematurely (gestational age 30+1/7 weeks) at an outside hospital and was transferred to our hospital under the diagnosis of cystic encephalomalacia, ventriculitis, and parenchymal abscess with shunt infection.

The Glasgow coma scale was only evaluated in six patients (24%) at diagnosis; severe brain injury (GCS ≤8) was diagnosed in two, moderate brain injury (GCS 9-12) in one, and minor brain injury (GCS ≥13) in three patients. Focal neurologic deficits were observed in seven patients (28%). Signs of increased intracranial pressure (IICP) such as vomiting, neck stiffness, or bulged fontanelle were observed in nine patients (36%).

### 3. Laboratory data

The median WBC count at diagnosis (n=24 patients) was 11,740/μL (range, 580-43,660/μL), the median level of C-reactive protein (n=24) was 1.69 mg/dL (range, 0.06-29.06 mg/dL), and the median erythrocyte sedimentation rate (n=18) was 23 mm/hr (range, 8-105 mm/hr). Lumbar puncture was performed in 14 patients (56%); the median CSF WBC was 206/μL (range, 0-15,700/μL); the median protein level was 158 mg/dL (range, 10-

1,502), and the median glucose level was 53 mg/dL (range, 2-85 mg/dL).

#### 4. Microbiological study

Microbiological diagnosis was confirmed in 64% of patients (16/25 patients) based on abscess cultures (n=5/13), blood cultures (n=6/21), CSF cultures (n=4/12), vegetation culture by open-heart surgery (n=1/2), or pathology reports (n=2/2). *Streptococcus intermedius* (n=3), *Staphylococcus aureus* (n=3), *Group B Streptococcus* (n=2), *Streptococcus pneumoniae* (n=1), *Escherichia coli* (n=1), *Pseudomonas aeruginosa* (n=1), *Aspergillus spp.* (*Aspergillus flavus*, *Aspergillus spp.*) (n=2), *Candidia albicans* (n=2), and a suspected fungal infection (n=1) were detected. Two patients had the same pathogens in both blood and CSF cultures: *Streptococcus pneumoniae* and *Pseudomonas aeruginosa*. *Staphylococcus intermedius* (n=3), *Staphylococcus aureus* (n=1), and *Aspergillus flavus* (n=1) were present in abscess cultures. *Candida albicans* was identified in a vegetation culture of one patient. The organisms present in two patients were confirmed by abscess pathology reports only; an *Aspergillus* species in one patient

and a suspected fungal infection (no species identification) in the other patient.

#### 5. Radiologic study

For radiologic diagnosis, computer tomography (CT, n=17), magnetic resonance (MRI, n= 5), or ultrasonography (US, n=3) images were obtained. Twenty-one patients were diagnosed with a brain parenchymal abscess, 3 patients with a subdural abscess, and 1 patient with an epidural abscess. Among 21 patients with brain parenchymal abscess, a single lesion was observed in 9 patients (43%) and multiple lesions were observed in 12 patients (57%). The distribution of single lesions was similar in both sides of the brain; five patients had abscesses in the right hemisphere and four had abscesses in the left hemisphere. The most common location of single abscesses was the temporal lobe (3/9, 33%) followed by the parietal lobe (2/9, 22%), frontoparietal lobe (1/9, 11%), basal ganglia (1/9, 11%), cerebellum (1/9, 11%), and occipital lobe (1/9, 11%).

#### 6. Treatment and outcomes

All patients received combination antimicrobial therapy. Seven

**Table 1.** Characteristics and Outcomes of Brain Abscesses in 25 Pediatric Patients

Patients	Sex	Age (years)	Underlying diseases/predisposing factors	Outcome	
				Mortality	Neurologic impairment
1	F	0.8	Preterm(GA 30+1/7 wks), VP shunt infection	Dead	NA
2	M	1.3	Preterm (GA 35+2/7 wks), poor oral hygiene due to tongue base lymphangioma	Alive	None
3	F	1.3	Preterm (36 wks), bicuspid aortic valve with aortic regurgitation, pneumonia sepsis with DIC and ICH	Alive	None
4	M	3.2	Tricuspid atresia	Alive	None
5	F	4.8	Head trauma	Alive	Dysarthria, limping gait
6	F	5.0	Ventricular septal defect	Alive	None
7	F	5.0	Medulloblastoma, neurosurgery	Dead	NA
8	F	5.3	R/O AVM, ICH, neurosurgery	Alive	Right hemiplegia
9	M	7.7	Pulmonary atresia	Dead	NA
10	M	7.9	MDS , patent foramen ovale,	Alive	None
11	M	8.4	Pulmonary stenosis with atrial septal defect	Alive	None
12	M	15.5	Preceding dental procedure, endocarditis	Alive	None
13	M	17.2	Lt COM with cholesteatoma	Alive	None
14	M	17.6	No underlying disease or predisposing factor	Alive	Hemianopsia
15	F	18.9	Rt COM with cholesteatoma	Alive	None
16	M	0.8	Agammaglobulinemia	Alive	None
17	F	13.1	Head trauma	NA	NA (lost to follow- up)
18	M	0.1	Patent foramen ovale, fungal endocarditis	Alive	None
19	F	0.1	Preceding meningitis	Alive	Cerebral palsy
20	M	1.7	AML	Alive	None
21	M	4.3	AOM	Alive	None
22	M	0.1	Preterm (GA 25+3/7 wks), patent ductus arteriosus, ICH	Dead	NA
23	F	1.3	Head trauma	Alive	Epilepsy
24	M	0.1	Preceding meningitis	Alive	None
25	F	1.0	Preterm (GA 28 wks), VP shunt infection	Alive	None

Abbreviations: MDS, myelodysplastic syndrome; AOM, acute otitis media; DIC, disseminated intravascular coagulation syndrome; AML, acute myeloblastic leukemia; COM, chronic otitis media; AVM; arterio-venous malformation; ICH, intra-cerebral hemorrhage; VP shunt, ventriculoperitoneal shunt; NA, not applicable

patients received medical treatment only and 18 patients received additional surgical interventions (17 neurosurgeries and 2 open-heart surgeries for vegetation removal). One patient had two neurosurgeries. Commonly performed neurosurgical procedures were bur hole drainage (n=9), surgical excision with open craniotomy (n=4), and image-guided stereotactic aspiration (n=3). The median duration of antimicrobial therapy was 42 days (range, 12-108 days). Commonly used antimicrobials were vancomycin (23/24, 96%), third-generation cephalosporin (19/24, 76%), metronidazole (13/24, 52%), and amphotericin B (5/24, 21%).

Four patients died and the overall fatality rate was 16% (4/25 patients). One patient was lost to follow-up. The median follow-up duration was 3.1 years in the remaining 20 patients (range, 0.2-13.2). Neurological impairments such as epilepsy, motor impairment (limping gait, hemiplegia), cerebral palsy, visual field defect (hemianopsia), were observed in 5 of 20 survivors (Table 1).

There was no statistical association between outcomes (fatality and neurological impairments) and the factors studied; age, sex, days from symptom onset to diagnosis, presence of congenital heart diseases, initial mental status, seizure at diagnosis, IICP at diagnosis, focal neurologic defect at diagnosis, initial body temperature, WBC counts, level of CRP, diagnostic images used (CT vs US vs MRI), and treatments used (medical treatment only vs surgery combined).

## Discussion

Brain abscesses are serious and life-threatening lesions of the CNS. They are uncommon in pediatric patients and most of the published literature comprises case reports. This study is one of the few to report comprehensive data on brain abscesses collected from 25 pediatric patients at a single tertiary center during a period of 14.7 years.

At the University of Virginia Children's Hospital between 2000-2007, an average of 1.5 children per year were admitted to the inpatient pediatric service with a primary diagnosis of brain abscess<sup>4</sup>. Lee et al<sup>24</sup> reported 27 pediatric cases of Korean children over 10 years, an average of 2.7 cases per year. In our study, an average of 1.67 pediatric patients per year were identified during 14.7 consecutive years. In terms of age distribution, brain abscesses occurred most commonly in patients younger than 2 years of age.

The clinical manifestations of brain abscesses initially tend to be nonspecific and there are no typical laboratory or CSF study results, which often causes a delay in diagnosis<sup>9, 10</sup>. The median interval from symptom onset to diagnosis was 11 days in our study, similar to another report (13 days)<sup>11</sup>. Previously, headache was

reported as the most common symptom of a brain abscess in non-pediatric patients<sup>12-14</sup>. In our study, fever was the most common presenting symptom. However, it should also be emphasized that fever is a common symptom of many other childhood illnesses<sup>15</sup>, and as many as 32% of children did not have high fever. Therefore, fever is not always a reliable indicator of a brain abscess in children.

Seydoux et al<sup>16</sup> observed focal neurologic deficits in 50% of their patients; these deficits generally occurred days to weeks after the onset of headache. They also reported that 25% of patients developed seizures and that having a seizure was the first manifestation of a brain abscess<sup>16</sup>. Lee et al<sup>24</sup> reported that 38% of their survivors had neurological sequelae. In our study, seizure was present in 48% of cases and focal neurologic deficits in 28% of cases. Neurological impairment was observed in 5 of 20 survivors with available follow-up data. However, not all patients had follow-up visits to our institution or long-term follow-ups of the same duration, and some patients' neurological conditions were not described in detail. Therefore, it is possible that the actual rate of neurological impairment in our study population could have been higher than what was observed.

In non-pediatric patients, the most commonly underlying diseases are diabetes mellitus and/or liver cirrhosis<sup>12</sup>. In pediatric patients, congenital heart disease has been reported to be the leading condition<sup>2</sup>. In our study, congenital heart disease was also the leading condition. Among 11 babies less than 2 years old, prematurity was the most common underlying condition (n=5) and congenital heart disease was the second most common underlying condition (n=3). Two patients were premature babies and also had congenital heart disease and intra-cerebral hemorrhage.

Radiology tests (CT or MRI) are tests of choice for the diagnosis and monitoring of brain abscesses<sup>14</sup>. In particular, MRI is more sensitive for detecting early cerebritis and estimates the extent of central necrosis more accurately than the other test modalities. CT scanning is not as sensitive as MRI for the diagnosis of brain abscesses, but is more easily performed in an emergency-room setting<sup>14</sup>. Ultrasonography is also a possible neuroimaging modality in infants who have an open fontanelle and sutures<sup>17</sup>. In addition, ultrasonography is a readily accessible and portable neuroimaging modality. Therefore, ultrasonography is very useful in pediatric patients. In our study, all three types of radiologic tests were used to diagnose brain abscesses. CT was the most commonly-used imaging modality (68% of patients) followed by MRI (16%) and ultrasonography (12%). Because most of patients were evaluated in the emergency room or the patient's condition was critical at the time of work-up for brain abscesses, CT was more frequently used than MRI in our study population.

Published fatality rates for brain abscesses range from 0 to 30%<sup>10, 16, 18-20, 24, 25)</sup>. In this study, the overall fatality was 16%. Several studies have failed to find an association between outcomes and the factors studied such as age, focal neurologic deficits, seizures, laboratory findings, causative organisms, characteristics of abscesses, and treatment modalities<sup>1, 14, 21-23)</sup>. In this study, there was no statistical association between outcomes and the factors studied.

Brain abscesses result in significant morbidity and high fatality. Because brain abscesses can have subtle initial presentations, a high level of suspicion is very important for early diagnosis in pediatric patients, particularly those with underlying conditions such as congenital heart disease or prematurity with a complicated postnatal course.

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