Brain Abscess in Infants and Children: A Retrospective Study of 107 Patients in Northeast Thailand

Narong Auvichayapat MD*,
Paradee Auvichayapat MD**, Sorarit Aungwarawong MD***

** Department of Pediatrics, Faculty of Medicine, Khon Kaen University, Khon Kaen*
*** Department of Physiology, Faculty of Medicine, Khon Kaen University, Khon Kaen*
**** Department of Pediatrics, Maha Sarakham Hospital, Maha Sarakham*

Objective: *To review the clinical manifestation, predisposing factor, location of abscess, causative organism, treatment, and outcome of brain abscess.*
Study design: *Descriptive retrospective study.*
Setting: *Srinagarind Hospital, Department of Pediatrics, Faculty of Medicine, Khon Kaen University, Khon Kaen.*
Material and method: *One hundred and seven infants and children with brain abscess that admitted between 1985 and 2005 are analyzed retrospectively.*
Results: *The mean age was 8.4 years. The male-to-female ratio was 1.3:1. The most common predisposing factor was congenital heart disease. The most common organisms in congenital heart disease, chronic otitis media, and unknown source were Streptococci, Proteus, and Staphylococcus aureus respectively. Two very rare cases of Citrobacter freundii brain abscesses were reported. Only 9.4% had classic triad signs and symptoms of brain abscess. The overall mortality rate was 10.7%.*
Conclusion: *The clinical features and outcomes of treatments of 107 infants and children with brain abscesses were reviewed. Congenital heart diseases and chronic otitis media were the most common predisposing factors. The common signs and symptoms were fever, headache, vomiting, alteration of consciousness, and focal neurologic deficit. The overall mortality rate was 10.7%.*

Keywords: *Brain abscess, Congenital heart disease, Chronic otitis media, Citrobacter freundii*

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Brain abscess is an uncommon occurrence in children[1]. The mortality rate associated with brain abscesses appears to be decreasing. This reduction is probably the result of the advent of neuroimaging techniques and its use to guide the management of brain abscess, improvements in neurosurgical techniques, and the advances in antibiotics[1]. Fischer EG et al found a reduction in mortality rate from 36% before 1970 to 14% after 1970[2]. Tekkok IH et al described a similar decline, from 30% in the era before the use of computed tomography (CT) to 6% in the last 5 years and zero in the last 3 years of their study[3]. Other case series also have reported a mortality rate of zero[4]. However, in Thailand, brain abscess is not uncommon and still causes significant mortality and morbidity. These resulted from the delayed diagnosis since some patients had no classic triad for diagnosis of brain abscess (headache, fever, and focal neurological deficits). The objective of the present study was to review the clinical manifestation, predisposing factors, location of abscess, causative organisms, treatments, and outcomes to improve the therapeutic strategy.

Correspondence to : Auvichayapat N, Division of Pediatric Neurology, Department of Pediatrics, Faculty of Medicine, Khon Kaen University, Khon Kaen 40002, Thailand. Phone: 043-348-382, Fax: 043-348-382, E-mail: anaron@kku.ac.th

Material and Method

The authors retrospectively reviewed the medical records of pediatric patients with brain abscesses admitted to the Division of Pediatric Neurology, Department of Pediatrics, Srinagarind Hospital,

which is the referral center in the northeast of Thailand, during the 21-year period from January 1985 to December 2005.

Inclusion criteria

1. Age below 15 years old.

2. Diagnosis of brain abscess by cranial CT or magnetic resonance images (MRI) with localized brain parenchymal lesion(s) with perilesional brain edema and post contrast ring enhancement, and it was associated with at least one of the following findings: positive cerebrospinal fluid (CSF) culture, pus-like material aspirated from intracerebral lesions during operation, histology suggesting a brain abscess, or strong clinical hints, including typical manifestations and improvement after antibiotic treatment[5].

3. For the non-surgically treated patients, the criterion was CT or MRI with improvement after antibiotic treatment[3].

Exclusion criteria

1. No medical record
2. Subdural empyema and epidural abscesses
3. Uncertain diagnosis

The following data were collected: age and sex, clinical manifestation, laboratory data including peripheral white blood cell (WBC) counts, location of abscess, underlying disease and the result of treatment. The result of 107 medical records presented as number and percentage in the frequency distribution tables.

Results

General characteristics

There were 168 patients recorded on the hospital database but only 107 medical records were found (63.5%). Sixty patients were male (56.1%) and forty-seven were female (43.9%). Male-to-female ratio was 1.3:1. Their ages ranged from 21 days to 15 years (mean, 8.3 years; median, 9 years; SD 4.4). There were seven patients younger than 1 year old (6.5%) with six infants (5.6%) and one neonate (0.9%).

Predisposing factors, location of abscesses and bacteriology

The authors analyzed the predisposing factors, location of abscesses and bacteriology simultaneously for the benefits of diagnosis and treatment. Congenital heart diseases and chronic otitis media were the most common predisposing factors, accounting for 72% of cases. The authors could not find a predisposing factor in 17.8% (Table 1).

Among congenital heart diseases, most of them were cyanotic heart diseases especially Tetralogy of Fallot (TOF) and transposition of great vessels (TGV). Most abscesses were located in the parietal and frontal lobes (83.3%). Eighteen patients (34%) had multiple abscesses (Table 2). The most common organisms were *streptococci* of various types, both aerobes and anaerobes (64.7%) (Table 3).

In chronic otitis media, the most common locations were cerebellum and temporal lobe (37.1% and 22.9% respectively) (Table 2). The majority organisms were gram negative rod (85.7%) and the most common were *Proteus* spp. and *Pseudomonas aeruginosa* (38.1 and 19.1 respectively). Only two cases were anaerobes (9.5%) (Table 3).

In 19 patients with unknown source and 11 miscellaneous sources, there were various locations and organisms (Table 2-4). *Staphylococcus aureus* (*S. aureus*) was the most common organism (30%). There were six infants with brain abscesses (5.6%). The organisms found were *Citrobacter freundii (C. freundii) and Streptococcus* spp. There were three infants and one neonate that had multiple brain abscesses (57.1%) (Table 5). The authors found a case of *mucormycosis*

Table 1. Predisposing factors for development of brain abscesses in 107 patients

Predisposing factor	No. of cases (%)
Congenital heart diseases (CHD)	53 (49.5)
Tetralogy of Fallot (TOF)	34 (31.8)
Transposition of great vessels (TGV)	8 (7.5)
Double outlet right ventricle (DORV)	3 (2.8)
Truncus arteriosus	2 (1.9)
Tricuspid atresia	2 (1.9)
Atrial septal defect (ASD)	2 (1.9)
Endocardial cushion defect	2 (1.9)
Chronic otitis media (COM)	24 (22.4)
Unknown	19 (17.8)
Meningitis	4 (3.7)
Facial infection	2 (1.9)
Nasal septal abscess	1 (0.9)
Sinusitis	1 (0.9)
Anatomical defect	2 (1.9)
Occipital dermal sinus tract	1 (0.9)
Frontoethmoidal meningo-encephalocele (FEEM)	1 (0.9)
Dental infection	2 (1.9)
Ruptured eye ball from dart injury	1 (0.9)

Table 2. Locations of brain abscesses in congenital heart diseases, chronic otitis media, and unknown source

Congenital heart diseases (n = 53)		Chronic otitis media (n = 24)		Unknown source (n = 19)	
Locations*	No. (%)	Locations**	No. (%)	Locations***	No. (%)
Parietal lobe	16 (26.7)	Cerebellum	13 (37.1)	Parietal lobe	4 (26.8)
Frontal lobe	10 (16.7)	Temporal lobe	8 (22.9)	PO lobe	4 (14.3)
FP lobe	9 (15.0)	Occipital lobe	4 (11.4)	Thalamus	4 (14.3)
PO lobe	5 (8.3)	Thalamus	3 (8.6)	FP lobe	3 (8.9)
PT lobe	5 (8.3)	Frontal lobe	3 (8.6)	Occipital lobe	3 (8.9)
Occipital lobe	4 (6.7)	Parietal lobe	2 (5.7)	Frontal lobe	2 (7.1)
FT lobe	2 (3.3)	TO lobe	1 (2.9)	Temporal lobe	2 (7.1)
PTO lobe	2 (3.3)	CP angle	1 (2.9)	PT lobe	1 (3.6)
Basal ganglia	2 (3.3)			FT lobe	1 (3.6)
Thalamus	2 (3.3)				
Temporal lobe	1 (1.7)				
FTP lobe	1 (1.7)				
Pons	1 (1.7)				

(FP = Fronto-parietal, PO = Parieto-occipital, PT = Parieto-temporal, FT = Fronto-temporal, PTO = Parieto-temporo-occipital, FTP = Fronto-temporo-parietal, TO = Temporo-occipital, CP = Cerebello-pontine
* Four patients had more than one discrete location
** Eleven patients had two discrete locations
*** Four patients had more than one location

Table 3. Organisms of brain abscesses in congenital heart diseases, chronic otitis media, and unknown source

Congenital heart diseases (n = 53)		Chronic otitis media (n = 24)		Unknown source (n = 19)	
Organisms*	No. (%)	Organisms*	No. (%)	Organisms	No. (%)
Streptococci	22 (64.7)	*Proteus* spp.	8 (38.1)	*Staphylococcus aureus*	3 (30.0)
Peptostreptococcus	6 (17.7)	*Proteus mirabilis*	4 (19.1)	*Microaerophilic streptococcus*	2 (20.0)
γ-*streptococcus*	5 (14.7)	*Proteus vulgaris*	4 (19.1)	*Staphylococcus epidermidis*	1 (10.0)
Microaerophilic	5 (14.7)	*Pseudomonas auruginosa*	4 (19.1)	*Peptostreptococcus* spp.	1 (10.0)
β-*streptococcus*	4 (11.8)	*Escherichia coli*	1 (4.8)	*Gardnerella vaginalis*	1 (10.0)
Viridans	2 (5.9)	*Citrobacter diversus*	1 (4.8)	*Kingella denitrificans*	1 (10.0)
Non-hemolytic	1 (2.9)	*Morganella morganii*	1 (4.8)	No growth	7 (36.8)
Diptheroids	3 (8.8)	*Klebsiella ozaenae*	1 (4.8)	No available data	3 (15.8)
Proprionibacterium acnes	2 (5.9)	*Providencia* spp.	1 (4.8)		
Fusobacterium	2 (5.9)	*Alcaligenes faecalis*	1 (4.8)		
Bacteroides spp.	1 (2.9)	*Peptostreptococcus*	1 (4.8)		
Bacillus spp.	1 (2.9)	*Bacteroides* spp.	1 (4.8)		
Hemophilus influenzae	1 (2.9)	*Enterococci*	1 (4.8)		
Acinitobacter spp.	1 (2.9)	No growth	2 (8.3)		
Gram-negative rod[D]	1 (2.9)	No available data	4 (16.7)		
No growth	17 (32.1)				
No available data	5 (9.4)				

* Three patients had two bacteria isolated
[D] Unidentified gram-negative rod

Table 4. Location of abscesses and organisms in 11 patients with miscellaneous sources

Predisposing factor	Location of abscesses	No. of isolates
Meningitis	Multiple fronto-parieto-occipital lobe	*Citrobacter freundii*
Meningitis	Multiple fronto-parieto-temporal lobe	*Citrobacter freundii*
Meningitis	Temporal lobe	β-*streptococcus* group A
Meningitis	Multiple fronto-parietal lobe	No growth
Dental infection	Occipital lobe	No growth
Dental infection	Fronto-parietal lobe	γ-*hemolytic streptococcus*
Nasal septal abscess	Frontal lobe	*Staphylococcus aureus*
Sinusitis	Multiple fronto-parietal lobe	*Mucormycosis*
Rupture eye ball from dart injury	Fronto-parietal lobe	No growth
Occipital dermal sinus tract	Cerebellum	*Streptococcus* not group A, B, D
Frontoethmoidal-meningoencephalocele	Multiple frontal lobe	α-*streptococcus* group D

Table 5. Brain abscesses in 6 infants and 1 neonate

Case No.	Age, sex	Predisposing factor	Location of abscess	Organisms
1.	10 days, female	Meningitis	Multiple frontal, occipital, parietal lobe	No growth
2.	2 months, male	Meningitis	Multiple	*Citrobacter freundii*
3.	2 months, male	Unknown	Frontal + occipital lobe	No growth
4.	3 months, female	Meningitis	Multiple	*Citrobacter freundii*
5.	5 months, male	FEEM	Multiple frontal lobe	α-*streptococcus* group D
6.	8 months, male	TOF	Frontal + occipital lobe	No growth
7.	9 months, female	Unknown	Cerebellum	*Streptococcus* spp.

in a 14 year-old boy without any underlying disease that was initially treated as bacterial brain abscess (Table 4).

Clinical features

The five most common initial signs and symptoms were fever, headache, vomiting, alteration of consciousness, and focal neurological deficit respectively. The classic triad of headache, fever, and focal neurological deficits was found in only 10 patients (9.4%) (Table 6).

Laboratory findings

Most of the patients had normal hematocrit and 29.9% had hematocrit higher than 50%. Most of the high hematocrit cases were cyanotic congenital heart diseases, with 79.4% that had leukocytosis of more than 10,000/mm^3 and most of them (61.7%) had neutrophils more than 75% (Table 7). Blood cultures were positive in only three (2.8%) of 107 patients. The organisms that were isolated were *C. freundii* in a 2 month-old boy with meningitis, *Klebsiella* spp in an

Table 6. Initial signs and symptoms of 107 patients with brain abscesses

Signs and symptoms	No. of cases (%) (n = 107)
Fever	93 (86.9)
Headache	85 (79.4)
Vomiting	63 (58.9)
Alteration of consciousness	45 (42.1)
Focal neurological deficit	42 (39.3)
Hemiparesis and cranial nerve palsy	17 (15.9)
Hemiparesis	15 (14.0)
Cranial nerve palsy	4 (3.7)
Cerebellar signs	3 (2.8)
Nystagmus	2 (1.9)
Cranial nerve palsy and cerebellar signs	1 (0.9)
Seizures	37 (34.6)
Papilledema	28 (26.2)
Neck stiffness	19 (17.8)
Blurring of vision	9 (8.4)
Ear pain and discharge per ear	9 (8.4)
Macrocephaly	2 (1.9)

8 year-old girl with meningitis and α-*Streptococcus* group D in a 5 month-old male infant with FEEM and meningitis. CSF cultures were also positive with the same organisms in all of them.

Management and outcome

The authors present only 75 cases since the authors referred the left patients back to the previous hospitals to receive the full courses of antibiotics or referred to other centers. So the authors included only the completely followed up cases. The overall mortality rate was 10.7% (Table 8). Two of the dead patients were referred after brain herniation without surgery. Two patients were palliative treated because the unfavorable prognosis of the underlying diseases (one was Down syndrome with endocardial cushion defect and the other was brain atrophy). Three cases were treated with full medications and surgery but died because of late presentation. The last one was the good consciousness case but died because of intra-operative hemorrhage.

Table 7. Summary of complete blood count (CBC) in 107 patients with brain abscesses

Complete blood count	No. of cases (%) (n = 107)
Hematocrit (%)	
≤ 30	10 (9.4)
31-40	42 (39.3)
41-50	23 (21.5)
51-60	17 (15.9)
≥ 60	15 (14.0)
Peripheral white blood cell counts (cells/mm^3)	
≤ 5,000	2 (1.9)
5,001-10,000	20 (18.7)
10,001-15,000	45 (42.1)
15,001-20,000	25 (23.4)
≥ 20,001	15 (14.0)
Neutrophils (%)	
≤ 55	9 (8.4)
56-75	32 (29.9)
≥ 76	66 (61.7)

Discussion

Brain abscess is not uncommon in the study institute. The hospital incidence is 8.4 cases per year. The average age of 8.3 years is slightly older than most other reports (mean about 7 years) but the age range and male to female ratio is similar[6-8]. Congenital heart disease was the most common predisposing factor like in other studies[6-8]. However, the authors found a high incidence of chronic otitis media (22.4%), which is higher than in the other reports[6-8] (10.2, 13 and 6% respectively). This finding was due to the poor socioeconomic status of the presented patients that usually neglected chronic otitis media without treatment for years. In congenital heart disease, the most common location of abscess is the parietal lobe, which is the area of brain perfused by the middle cerebral artery. The high incidence of multiple abscesses (34%) supports hematogenous spreading in this condition. The most common organisms were *Streptococci* both aerobes and anaerobes. This finding is similar to the report by S□ez-Llorens XJ, et al[9]. In chronic otitis media, the most common location of abscesses is the cerebellum that was similar to the review of Spinnato S, et al[10]. The present study reports a rare case of cerebello-pontine abscess, which also had one in the present study. The most common organism is *Proteus* spp, which is similar to the report of Sennaroglu L, et al[11]. Yaki HI found that *Proteus* spp was the commonest organism in chronic otitis media[12]. Nearly all of the organisms that were found in the present study were gram negative rods, which were the same organisms that caused

Table 8. Summary of management and outcome in 75 patients with brain abscesses*

Treatment	No. of patients	Survives (%)	Deaths (%)
Surgical and medical			
Aspiration	38 (50.7)	34 (89.5)	4 (10.5)
Aspiration and excision	22 (29.3)	21 (95.5)	1 (4.6)
Excision	4 (5.3)	4 (100.0)	0 (0.0)
Medical only	11 (14.7)	8 (72.7)	3 (27.3)
Total	75 (100.0)	67 (89.3)	8 (10.7)

* Included only the completely followed up cases

chronic otitis media[13]. Therefore, this finding supports direct extension mechanism as the pathogenesis of brain abscess in chronic otitis media. In 19 patients with unknown source**,** the most common location was the parietal lobe and the most common organism was *S. aureus.* The pathogenesis in this group is unknown but the authors think there may be occult hematogenous spreading from skin because the location was the same as in congenital heart disease. Brain abscess in the infancy period is rare. The authors found only six cases of infant brain abscesses (5.6%), two of them were *C. freundii* multiple brain abscesses complicated from meningitis. *C. freundii* brain abscess is very rare, there were only two neonates with multiple brain abscesses that occurred after *C. freundii* meningitis previously reported in Medline database[14,15].

The classic triad of brain abscess was found in only 9.4%. Therefore, a number of the presented patients were late diagnosed leading to delayed treatment and a significant mortality rate. The five most common initial signs and symptoms were fever, headache, vomiting, alteration of consciousness and focal neurological deficit are the clinical manifestations that help to make diagnosis. About one third (29.9%) had hematocrit higher than 50% that resulted in polycythemic thrombosis and focal areas of ischemia, leading to abscess formation. One fifth had normal peripheral white blood cell counts and two fifth had normal neutrophil count. Therefore, the doctors should suspect brain abscess in the patient who has the aforementioned signs and symptoms although he has normal white blood cells.

In the study institute, the management of brain abscess includes antibiotics with or without aspiration, excision, or both, depended on situation. The mortality rate was still high (10.7%) which mainly the result of late presentation or delayed diagnosis.

Conclusion

The age, sex, clinical manifestation, predisposing factor, locations of abscess, causative organism, treatment, and outcome of 107 infants and children with brain abscesses were reviewed. Congenital heart diseases and chronic otitis media were the most common predisposing factors. The most common organisms in congenital heart diseases were Streptococci both aerobes and anaerobes. In chronic otitis media, the majority of organisms were gram negative rods especially *Proteus* and *Pseudomonas*. The common signs and symptoms were fever, headache, vomiting, alteration of consciousness, and focal neurologic deficit. Awareness of brain abscess in the children who have a predisposing factor will help to diagnose brain abscess. The overall mortality rate was 10.7%.

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การศึกษาย้อนหลังโรคฝีในสมอง 107 รายในผู้ป่วยเด็กภาคตะวันออกเฉียงเหนือของประเทศไทย

ณรงค์ เอื้อวิชญาแพทย์, ภารดี เอื้อวิชญาแพทย์, สรฤทธิ์ อังวราวงศ์

วัตถุประสงค์: *เพื่อทบทวนอาการ อาการแสดง ปัจจัยเสี่ยง ตำแหน่งของฝีในสมอง เชื้อที่เป็นสาเหตุ การรักษาและผลการรักษาโรคฝีในสมอง*

ประเภทงานวิจัย: *การศึกษาย้อนหลังเชิงพรรณนา*

สถานที่ทำการวิจัย: *โรงพยาบาลศรีนครินทร์ มหาวิทยาลัยขอนแก่น*

วัสดุและวิธีการ: *ทบทวนและวิเคราะห์ย้อนหลังจากเวชระเบียนของผู้ป่วยเด็กฝีในสมองที่เข้ารับการรักษา 107 ราย ระหว่างปี พ.ศ.2528 - พ.ศ. 2548*

ผลการศึกษา: *อายุเฉลี่ย 8.4 ปี สัดส่วนเพศชายต่อหญิง 1.3:1 ปัจจัยเสี่ยงที่พบบ่อยที่สุดคือโรคหัวใจพิการแต่กำเนิด เชื้อที่เป็นสาเหตุที่พบบ่อยที่สุดในโรคหัวใจพิการแต่กำเนิด, โรคหูน้ำหนวกเรื้อรัง และที่ไม่รู้สาเหตุ ได้แก่ Streptococci, Proteus และ Staphylococcus aureus ตามลำดับ มีผู้ป่วย 2 รายที่เกิดจากเชื้อ Citrobacter freundii ซึ่งเคยมีรายงานไว้น้อยมาก มีผู้ป่วยเพียงร้อยละ 9.4 เท่านั้นที่มีอาการหลักของฝีในสมองครบ 3 อย่าง อัตราตายรวมร้อยละ 10.7*

สรุป: *การศึกษานี้ได้ทบทวนลักษณะทางคลินิกและผลการรักษาผู้ป่วยเด็กฝีในสมอง 107 ราย ปัจจัยเสี่ยงที่พบบ่อยที่สุดคือโรคหัวใจพิการแต่กำเนิดและโรคหูน้ำหนวกเรื้อรัง อาการและอาการแสดงที่พบบ่อยได้แก่ ไข้ ปวดศีรษะ อาเจียน การรับรู้สติเปลี่ยนแปลงและ focal neurologic deficit อัตราตายรวมร้อยละ 10.7*