Predictive Factors of the Outcome and Intraventricular Rupture of Brain Abscess

Thara Tunthanathip MD*,
Kanet Kanjanapradit MD**, Sakchai Sae-Heng MD*,
Thakul Oearsakul MD*, Ittichai Sakarunchai MD*

** Division of Neurological Surgery, Department of Surgery, Faculty of Medicine, Songklanagarind Hospital, Prince of Songkla University, Songkhla, Thailand*
*** Department of Pathology, Faculty of Medicine, Songklanagarind Hospital, Prince of Songkla University, Songkhla, Thailand*

Objective: *To identify the significant factors predicting a favorable outcome and to study clinical characteristics and identify the factors predicted by intraventricular rupture of brain abscess (IVROBA).*
Material and Method: *In the retrospective study, the computer-based medical records of patients of a tertiary care hospital between 1999 and 2013 were reviewed. Univariate and multivariate analyses were used to determine the significant factors predicting the outcomes and IVROBA.*
Results: *One hundred fourteen patients with brain abscesses were enrolled. The predictive factor of a favorable outcome was Glasgow Coma Scale (GCS) score 13 to 15 (OR 14.64; 95% CI 2.70-79.34; p = 0.02). Conversely, the factors associated with an unfavorable outcome were fungal brain abscess (OR 40.81; 95% CI 3.57-466.49; p = 0.003) and IVROBA (OR 5.50; 95% CI 1.34-22.49; p = 0.017). Moreover, greater distance of the brain abscess from the ventricle decreased the IVROBA (OR 0.62; 95% CI 0.45-0.87; p = 0.005). Abscesses with intraventricular rupture that were at less than 7 mm of a ventricle (p<0.000) were likely to IVROBA.*
Conclusion: *The outcome of a brain abscess depends on good clinical status, pathogens, and fatal complication of IVROBA. If poor prognostic factors exist, then better surgical option can be selected.*

Keywords: *Brain abscess, Intraventricular rupture, Ventriculitis, Fungal brain abscess, Predictive factor*

J Med Assoc Thai 2015; 98 (2): 170-80
Full text. e-Journal: *http://www.jmatonline.com*

Brain abscess is a serious intracranial infection. Although the development of diagnostic neurological imaging and the efficacy of antibiotics have improved, the mortality rate is still 20%[1-3].

Prognostic factors of brain abscesses were studied by few clinical researchers. Male, the performance status of the patient, and gram-positive bacteria were reported to be good prognostic factors in the previous studies. On the contrary, the poor prognostic factors of brain abscesses were found to be the initial Glasgow Coma Scale (GCS) score <12, acquired immune deficiency syndrome (AIDS), nasopharyngeal carcinoma, hematologic disease, deep-seated brain abscess, fungi, and medical treatment alone[4,5].

Intraventricular rupture of brain abscess (IVROBA) was mentioned as one of the significant factors associated with mortality. The fatal complication reported 38.7 to 80% of mortality[6]. However, IVROBA was an insignificant prognostic factor in multivariate analysis in a recent study[5]. Furthermore, few studies searched for predictive factors of IVROBA[7,8].

The aims of the present study were: 1) to identify the significant factors predicting favorable outcome, 2) to study clinical characteristics and identify the factors predicted by IVROBA.

Correspondence to:
Tunthanathip T, Division of Neurological Surgery, Department of Surgery, Faculty of Medicine, Songklanagarind Hospital, Prince of Songkla University, Korhong, Hat Yai, Songkhla, 90110, Thailand.
Phone: +66-74-451401-4, Fax: +66-74-429384
E-mail: tthara@medicine.psu.ac.th, tsus4@hotmail.com

Material and Method

Study population

The study was a retrospective study. We search patients from the International Statistical Classification of Diseases and Related Health Problems Tenth Revision (ICD-10), whom were diagnosed as intracranial abscess in the referral tertiary care hospital in the southern part of Thailand between January 1, 1999 and December 31, 2013. The Human Research Ethics Committee of the Faculty of Medicine, Songklanagarind hospital, Prince of Songkla University approved the study.

The inclusion criteria comprised of available medical records, cranial computed tomography (CT) scan, or magnetic resonance imaging (MRI) showing a rim-enhancing lesion and other findings that suspected of brain abscesses were associated with at least one of the following four conditions, 1) the characteristic of intracranial specimens was frank pus, 2) intracranial specimens found to be organisms, 3) histopathological examination confirmed abscess or organisms, 4) in medical case, patients diagnosed as a brain abscess with restrict diffusion weight imaging (DWI) on MRI[9], or positive of either hemoculture or cerebral spinal fluid (CSF) culture. The medical records, radiological imaging and details of microorganisms were reviewed. Patient demographic and predisposing factors, such as sex, underlying diseases, source of infection, diabetes mellitus, congenital heart disease, postcraniotomy, trauma, and sepsis status[10] were reviewed from the computer based medical record database.

Brain abscess analyses

Microorganisms were isolated from intracranial specimens or histopathology from neurological operations. In medical case, patients' CSF culture and blood culture results were reviewed in accordance with the primary source of infection.

Based on neuroimaging, the location, number and other characteristics of brain abscesses were retrieved such as leptomeningeal enhancement, multiloculation, venous thrombosis, and hydrocephalus.

The maximum diameter of the brain abscess was measured and the volume calculated from ellipsoid's formula. The nearest distance between the inner capsule of the abscess and the ventricle was measured perpendicularly in the axial plane of the post contrast imaging. A "periventricular abscess" in the study is defined as a brain abscess that has a distance between the capsule of the abscess and the ventricle of less than 1 mm. A "deep seated abscess" in the study is defined as a brain abscess that had a distance between the outer capsule of the abscess and the cortical surface in the axial plane of more than 10 mm.

In the present study, intraventricular rupture of a brain abscess is defined as the rim-enhancing lesion directly extended into the ventricle, and found ventriculitis or ependymitis on a contrast-enhanced CT or MRI brain scan.

Treatment and outcome

Medical and surgical treatments were reviewed. Several neurological interventions were performed. Any operations that had the objective to aspirate the brain abscesses were grouped into aspiration procedures. Any operations to remove a brain abscess were grouped into excision procedures. Other specific procedures were grouped into external ventricular drainage and a transphenoid approach with abscess drainage.

Outcome was assessed and categorized according to the Extended Glasgow Outcome Scale (GOSE) at 6-month end point retrospectively. GOSE was dichotomized and 1 to 4 was regarded as an unfavorable outcome while GOSE 5 to 8 was considered a favorable outcome[11].

Statistical analysis

Mean with standard deviation and median with interquartile range (IQR) were calculated for descriptive purposes. For comparisons of dichotomous factors between groups, the Chi-square test and Fisher's exact test were used. The Student's t-test was performed for comparing the means of two groups in the normal distribution data. The Mann-Whitney U test was used in the skewed distribution data. The univariate logistic regression analysis was used to compare the differentiation of odds of favorable outcome and IVROBA between groups. Finally, the multivariate logistic regression analysis was used to adjust odds to identify significant factors predicted to the favorable outcome and IVROBA. Statistical analysis was performed using R program with epical version 3.0.1 for analysis. All test were 2-tailed and $p<0.05$ was considered significant.

Results

Patient's characteristics

One hundred twenty one patients were diagnosed with brain abscesses between January 1999 and December 2013. Of these, three patients were excluded due to subdural empyema, three patients due to unavailability of the intracerebral specimen results, one patient due to metastatic adenocarcinoma, leaving the study population to 114 patients that fulfilled the criteria. The baseline characteristics of the patients are described in Table 1. The median age of the study was 41 years (IQR 20 to 59). Fifty-seven point nine percent (57.9%) of the patients were male, 89.5% of patients had predisposing factors, of which 15.8% had a contiguous infectious source, 19.3% had a hematogenous origin, 4.4% had trauma, 38.6% were post craniotomy operations, and 11.5% were immunocompromised hosts. Median time of symptoms

Table 1. Characteristics of the patients

Factors	Total (n = 114)	Unfavorable outcome (n = 43)	Favorable outcome (n = 71)	*p*-value (x^2)
Age (year), median (IQR)	41.0 (20.0-59.0)	49.0 (26.0-65.0)	40.0 (18.0-53.0)	0.08*
Male sex, n (%)	66 (57.9)	25 (58.1)	41 (57.7)	0.55
Time of symptoms (day), median (IQR)	14.0 (7.0-29.0)	14.0 (7.0-33.0)	4.0 (5.0-23.0)	0.074*
Predisposing factors				0.113
Contiguous origin, n (%)				
Otitis media/mastoiditis	5 (4.4)	3 (60.0)	2 (40.0)	
Sinusitis	4 (3.5)	2 (50.0)	2 (50.0)	
Dental	6 (5.3)	1 (16.7)	5 (83.3)	
Recent meningitis	3 (2.6)	1 (2.3)	2 (2.8)	
Hematogenous origin, n (%)				
Congenital heart disease	16 (14.0)	2 (12.5)	14 (87.5)	
Pneumonia	5 (4.4)	2 (40.0)	3 (60.0)	
Other infection	1 (0.9)	1 (100.0)	0 (0.0)	
Trauma, n (%)	5 (4.4)	3 (60.0)	2 (40.0)	
Post-craniotomy, n (%)	44 (38.6)	18 (40.9)	26 (59.1)	
Immunocompromise host, n (%)				
Acquired immuno deficient syndrome	3 (2.6)	2 (66.7)	1 (33.3)	
DM	2 (1.8)	0 (0.0)	2 (100.0)	
Cirrhosis	2 (1.8)	1 (50.0)	1 (50.0)	
Hematologic disorder/FNP	4 (3.5)	3 (75.0)	1 (25.0)	
Steroid treatment	1 (0.9)	1 (100.0)	0 (0.0)	
Prolong antibiotics	1 (0.9)	1 (100.0)	0 (0.0)	
Cryptogenics, n (%)	12 (10.5)	2 (16.7)	10 (83.3)	
Clinical features, n (%)				
Headache	30 (26.3)	8 (18.6)	22 (23.8)	0.19
Fever	52 (45.6)	24 (55.8)	28 (41.8)	0.22
Focal neurological deficits	34 (29.8)	16 (37.2)	18 (26.9)	0.48
Meningism	17 (14.9)	8 (18.6)	9 (13.4)	0.31
Siezure	22 (19.3)	7 (16.3)	15 (22.4)	0.43
Alteration	34 (29.8)	21 (48.8)	13 (19.4)	0.004
Karnofsky performance score				0.000
<80	62 (54.4)	36 (85.7)	26 (38.8)	
>80	47 (41.2)	6 (14.3)	41 (61.2)	
GCS, n (%)				0.000
3-8	11 (10.1)	8 (19.0)	3 (4.5)	
9-12	18 (16.5)	12 (28.6)	6 (9.0)	
13-15	80 (70.2)	22 (52.4)	58 (86.6)	
Albumin level (mg%), median (IQR)	3.6 (2.9-3.6)	3.2 (2.8-3.8)	3.7 (3.1-4.1)	0.027*
Microorganisms, n (%)				0.001
Sterile	42 (39.2)	16 (40.0)	26 (38.8)	
Bacteria				
Gram positive	26 (24.2)	10 (25.0)	16 (23.8)	
Gram negative	10 (9.3)	2 (5.0)	8 (11.9)	
Anaerobes	9 (8.4)	0 (0.0)	9 (13.4)	
Mixed	6 (5.6)	3 (7.5)	3 (4.5)	
Norcardia	3 (2.8)	0 (0.0)	3 (4.5)	
Myobacterium tuberculosis	1 (0.9)	0 (0.0)	1 (1.5)	
Fungi	10 (9.3)	9 (22.5)	1 (1.5)	

DM = diabetes mellitus; FNP = Febrile neutropenia; IQR = interquartile range; GCS = Glasgow coma scale; SIRS = systematic inflammatory response syndrome; IVROBA = intraventricular rupture of a brain abscess; GOSE = extended Glasgow outcome scale

* Mann-Whitney U test

+ Student's t-test

Table 1. (cont.)

Factors	Total (n = 114)	Unfavorable outcome (n = 43)	Favorable outcome (n = 71)	*p*-value (x^2)
Positive hemoculture	13 (11.5)	8 (18.6)	5 (7.1)	0.11
Sepsis status, n (%)				0.000
Normal	49 (43.4)	8 (18.6)	41 (58.6)	
SIRS	18 (15.9)	3 (7.0)	15 (21.4)	
Sepsis	16 (14.2)	11 (25.6)	5 (7.1)	
Severe sepsis	18 (15.9)	11 (25.6)	7 (10.0)	
Septic shock	5 (4.4)	4 (9.3)	1 (1.4)	
Multiorgan failure	7 (6.2)	6 (14.0)	1 (1.4)	
Number of brain abscess, n (%)				0.89
Single	76 (66.7)	29 (67.4)	47 (66.2)	
Multiple	38 (33.3)	14 (32.6)	24 (33.8)	
Diameter of brain abscess (cm), mean (SD)	4.1 (1.5)	4.4 (1.6)	3.9 (1.4)	0.71+
Volume of brain abscess (ml), median (IQR)	13.9 (7.0-31.9)	15.1 (7.6-39.7)	12.5 (6.7-27.5)	0.26*
IVROBA, n (%)	26 (23.6)	17 (40.5)	9 (13.2)	0.018
Type of surgery, n (%)				0.08
Medication alone	10 (8.9)	5 (11.6)	5 (7.0)	
Aspiration	46 (41.1)	13 (30.2)	33 (46.5)	
Craniotomy with excision	50 (44.6)	20 (46.5)	30 (42.3)	
Ventriculostomy	3 (2.7)	3 (7.0)	0 (0.0)	
Transphenoid approach with abscess drainage	3 (2.7)	2 (4.7)	1 (1.4)	
GOSE				
Upper good recovery	26 (22.8)			
Lower good recovery	25 (22.0)			
Upper moderate disability	16 (14.0)			
Lower moderate disability	4 (3.5)			
Upper severe disability	4 (3.5)			
Lower severe disability	4 (3.5)			
Vegetative state	4 (3.5)			
Death	31 (27.2)			

DM = diabetes mellitus; FNP = Febrile neutropenia; IQR = interquartile range; GCS = Glasgow coma scale; SIRS = systematic inflammatory response syndrome; IVROBA = intraventricular rupture of a brain abscess; GOSE = extended Glasgow outcome scale

* Mann-Whitney U test

+ Student's t-test

was 14 days (IQR 7 to 29), three patients (2.6%) presented with triads of symptoms (fever, headache, and focal neurological deficit).

Microbiology

Two-thirds of intracranial pus isolated had microorganisms, 24.2% were gram positive bacteria, 9.3% were gram-negative, 8.4% were anaerobes and 5.6% were mixed organisms, 39.2% were sterile abscesses (Table 2). However, 29.3% gram strain found mixed organisms in this group.

Ten patients had fungal abscess, 60% were Aspergillosis and the other were rare fungi such as *Rhizopus* spp., *Pseudoallescheria boydii*, *Cladosporium trichoides* (Fig. 1). Fifty percent (50%) of fungal infections had sinusitis, 30% had diabetes mellitus (DM), 20% had hematologic malignancy with febrile neutropenia (FNP), and 20% AIDS host. The mortality rate of fungal abscess was 90%.

Treatment and outcome

Of the 10 patients (8.9%) that were on medication alone, seven patients were diagnosed of brain abscess from restrict DWI on MRI, and three patients were positive hemoculture with rim-enhancing lesions. In the present study, 62.3% of patients had favorable outcome. Overall mortality rate of brain abscess was 27.2%.

Table 2. Microorganisms isolated from brain abscess

Microorganisms (n = 107)	No. of patient (%)
Sterile	42 (39.2)
Gram positive	
Streptococcus spp.	10 (9.3)
Straphylococcus spp.	10 (9.3)
Staphylococcus epidermidis	4 (3.7)
Corynebacterium	2 (1.8)
Gram negative	
Klebsiella pneumoniae	4 (3.7)
Pseudomonas spp.	3 (2.8)
Enterobacter cloacae	2 (1.8)
Enterococcus	1 (0.9)
Anaerobes	
Propionibacterium	7 (6.6)
Peptostreptococcus	2 (1.8)
Mixed	6 (5.6)
Norcardia	3 (2.8)
Mycobacterium tuberculosis	1 (0.9)
Fungi	
Aspergillosis	6 (5.6)
Cladosporium trichoides	1 (0.9)
Pseudoallescheria boydii	1 (0.9)
Rhizopus spp.	1 (0.9)
Hyphae-form mucormycosis	1 (0.9)

Predictive factors of outcome

For the primary objective analyses, odd ratios of favorable outcomes were calculated from several factors. The univariate logistic regression analysis was used and the significant factors from initial analysis were calculated using multivariate regression analysis.

The factors initially associated with the outcome were Karnofsky performance score (KPS), GCS, sepsis status, albumin level, microorganisms, and IVROBA from the univariate analysis. Finally, the multivariate analysis demonstrated that the patients with GCS 13 to 15 (OR 14.64; 95% CI 2.70-79.34; $p = 0.02$) had potentially increased odds of a favorable outcome (Table 3). On the other hand, the factors associated with the unfavorable outcome were fungal brain abscess (OR 40.81; 95% CI 3.57-466.49; $p = 0.003$) and IVROBA (OR; 5.50; 95% CI 1.34-22.49; $p = 0.017$).

Predictive factors of IVROBA

For the secondary objective analyses, twenty-five patients were IVROBA with subsequent rupture and a patient was initially ruptured so the distance between abscess and ventricle could not be measured. The patients with IVROBA had more severe cases than in the other group. The clinical performance status (KPS, GCS), sepsis status, fever, meningism, and infected CSF profile were significantly more severe when compared with non-IVROBA patients (Table 4). In univariate analyses, the following significant factors were associated with IVROBA, leptomeningeal enhancement, multiloculation, multiple lesions, volume of brain abscess more than 20 ml, and the distance between abscess and ventricle. The multivariate analyses confirmed that the distance between abscess and ventricle is a potential factor (OR 0.62; 95% CI 0.45-0.87; $p = 0.005$) (Table 5). Additionally, the authors categorized brain abscesses according to the distance of the abscess and ventricle. The results showed 90% of periventricular abscess were intraventricular rupture (Fig. 2). Conversely, the brain abscess without IVROBA had a distance of more than 7 mm away from a ventricle compared with IVROBA group (Fisher's exact test; $p = 0.000$).

Discussion

In the retrospective study, the authors observed the factors associated with a favorable outcome. The patient's GCS, performance status were potential prognostic factors in several serious diseases,

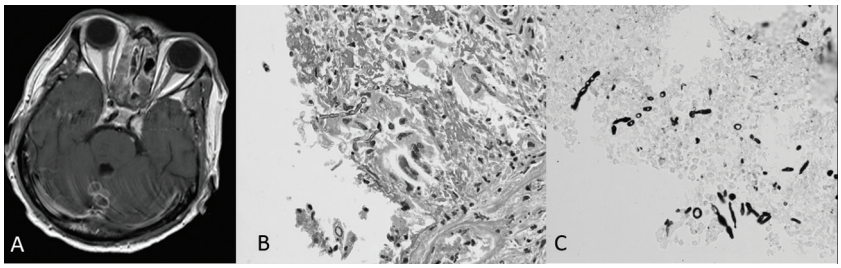

Fig. 1 *Cladosporium trichoides* of cerebellum. (A) Axial contrast-enhanced T1-weighted image demonstrates the multilocuated enhancing rim lesions at cerebellum. (B) Histological slide shows fungal organism with brown pigmented septate round bodies and pigmented branching hyphae in the brain tissue consistent with *Cladosporium* spp. (C) GMS staining demonstrates round bodies and hyphae of fungus.

Table 3. Odds of favorable outcome of brain abscess

Factor	Univariate analysis		Multivariate analysis	
	Odds (95% CI)	*p*-value	Odds (95% CI)	*p*-value
Time of symptoms, n (%)				
<10 days	References			
≥10 days	0.64 (0.28-1.44)	0.28		
Sepsis status, n (%)				
Normal	References			
SIRS	0.97 (0.22-4.17)	0.97		
Sepsis	0.08 (0.02-0.32)	0.000		
Severe sepsis	0.12 (0.03-0.41)	0.001		
Septic shock	0.04 (0.005-0.49)	0.01		
Multiorgan failure	0.03 (0.003-0.30)	0.003		
Albumin level, mg%	0.95 (0.82-1.11)	0.54	1.02 (0.82-1.27)	0.80
GCS, n (%)				
3-8	References		References	
9-12	0.14 (0.04-0.45)	0.001	0.87 (0.98-7.84)	0.90
13-15	0.14 (0.03-0.58)	0.007	14.64 (2.70-79.34)	0.02
Microorganisms, n (%)				
Bacteria	References		References	
Sterile	0.65 (0.27-1.55)	0.33	0.58 (0.15-2.17)	0.58
Fungi	0.038 (0.004-0.31)	0.003	0.01 (0.002-0.16)	0.001
IVROBA, n (%)	0.18 (0.07-0.48)	0.001	0.19 (0.04-0.83)	0.028

GCS = Glasgow coma scale; SIRS = systematic inflammatory response syndrome; IVROBA = intraventricular rupture of a brain abscess

which include intracranial abscess[4,12,13]. Moreover, the present study tests the association between the prognosis of a brain abscess and several factors.

Fungal abscess

The pathogen is mentioned as one of the poor prognostic factors. In prior studies, a fungal abscess was mainly involved in immunosuppressed patients and is a fatal infection[14]. Though a combination of treatments that includes both medication and surgical operation, the mortality rate of fungal abscess is 28 to 100%[15-19].

In the present study, the fungal abscess was significantly a fatal organism and almost all patients died. However, this serious central nervous system (CNS) infection was studied in randomized controlled trials, prospective cohorts that improved the outcome in these patients.

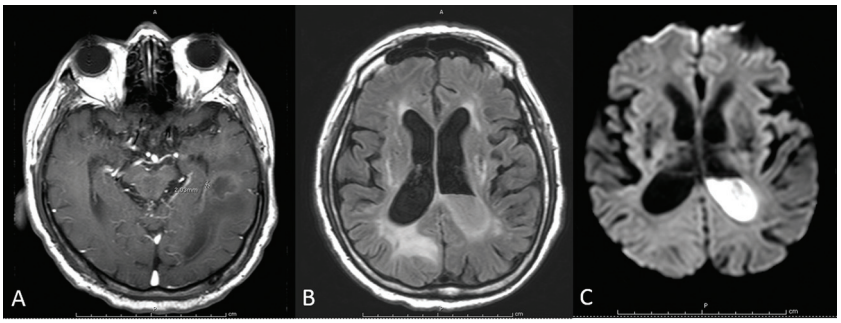

Fig. 2 Left temporal abscess with intraventricular rupture. (A) Axial contrast-enhanced T1-weighted image demonstrates a well-defined, thin enhancing rim lesion at left temporal lobe. (B) Axial FLAIR image demonstrates fluid-debris level within ventricle after abscess rupture. (C) Axial diffusion-weighted image demonstrates restricted diffusion of fluid-debris level.

Table 4. Comparison of clinical characteristics and neuroimaging finding between brain abscesses with or without intraventricular rupture

Factor	IVROBA (n = 26)	Without IVROBA (n = 84)	*p*-value (x^2)
Age (year), median (IQR)	31.5 (13.0-65.0)	42.0 (23.5-58.5)	0.26*
Male sex, n (%)	9 (34.6)	37 (44.0)	0.39
Time of symptoms (day), median (IQR)	20.5 (10.0-30.0)	10.0 (5.0-22.0)	0.12*
Predisposing factors, n (%)			0.40
Contiguous	7 (28.0)	23 (28.0)	
Hematogenous	2 (8.0)	4 (4.9)	
Trauma	3 (12.0)	2 (2.4)	
Post-craniotomy	8 (32.0)	34 (41.5)	
Immunocompromised	2 (8.0)	11 (13.4)	
Crytogenic	3 (12.0)	3 (12.0)	
Clinical features, n (%)			
Headache	9 (34.6)	19 (23.8)	0.27
Fever	18 (69.2)	33 (41.3)	0.013
Focal neurological deficits	11 (42.3)	23 (28.8)	0.19
Meningism	11 (42.3)	4 (5.0)	0.000
Siezure	6 (23.1)	16 (20.0)	0.73
Alteration	14 (53.8)	19 (23.8)	0.004
GCS, n (%)			0.008
3-8	1 (4.2)	10 (12.3)	
9-12	8 (33.3)	7 (8.6)	
13-15	15 (62.5)	64 (79.0)	
Microorganisms, n (%)			0.11
Bacteria	7 (30.4)	44 (55.0)	
Sterile	13 (56.5)	29 (36.5)	
Fungi	3 (13.0)	7 (8.5)	
Positive hemoculture, n (%)	8 (18.6)	5 (7.1)	0.11
Infected CSF profile, n (%)	14 (77.8)	14 (45.2)	0.026
Mortality, n (%)	13 (50.0)	17 (20.2)	0.003
Neuroimaging features, n (%)			
Frontal	13 (50.0)	45 (53.6)	0.75
Parietal	6 (23.1)	37 (44.0)	0.55
Temporal	8 (30.8)	16 (19.0)	0.29
Occipital	6 (23.1)	16 (19.0)	0.65
Posterior fossa	4 (15.4)	9 (10.7)	0.51
Deep seated	13 (50.0)	10 (11.9)	0.000
Leptomeningeal enhancement, n (%)	23 (88.5)	49 (58.3)	0.005
Multiloculation, n (%)	14 (53.8)	11 (13.4)	0.000
Hydrocephalus, n (%)	19 (73.1)	19 (22.6)	0.001
Focal enlargement	4 (21.0)		
Generalized enlargement	15 (79.0)		
Number of brain abscess, n (%)			0.006
Single	12 (46.2)	63 (75.0)	
Multiple	14 (53.8)	21 (25.0)	
Diameter of brain abscess, cm			0.70
<2.5	3 (11.5)	12 (14.5)	
≥2.5	23 (88.5)	71 (85.5)	

CSF = cerebrospinal fluid; IQR = interquartile range; GCS = Glasgow coma scale; IVROBA = intraventricular rupture of a brain abscess

* Mann-Whitney U test

+ Percent of the rows

Table 4. (cont.)

Factor	IVROBA (n = 26)	Without IVROBA (n = 84)	*p*-value (x^2)
Volume of brain abscess, ml			0.001
<20	8 (32.0)	57 (70.4)	
≥20	17 (68.0)	24 (29.6)	
Site of intraventricular rupture, n (%)			
Frontal horn	11 (44.0)		
Occipital horn	5 (20.0)		
Temporal horn	6 (24.0)		
Third ventricle	1 (4.0)		
Forth ventricle	2 (8.0)		
Fluid-debris level, n (%)	15 (57.7)		
Time to rupture (day), mean (SD)	12.3 (18.0)		
Time to hydrocephalus (day), mean (SD)	26.7 (17.3)		
Distance between abscess and ventricle, n (%)+			
0-0.9 mm	18 (90.0)	2 (10.0)	
1-1.9 mm	1 (33.3)	2 (66.7)	
2-2.9 mm	1 (14.3)	6 (85.7)	
3-3.9 mm	1 (14.3)	6 (85.7)	
4-4.9 mm	2 (50.0)	2 (50.0)	
5-5.9 mm	1 (20.0)	4 (80.0)	
6-6.9 mm	1 (20.0)	4 (80.0)	
≥7 mm	0 (0)	47 (100)	

CSF = cerebrospinal fluid; IQR = interquartile range; GCS = Glasgow coma scale; IVROBA = intraventricular rupture of a brain abscess

* Mann-Whitney U test

+ Percent of the rows

Table 5. Odds of intraventricular rupture of brain abscess

Factor	Univariate analysis		Multivariate analysis	
	Odds (95% CI)	*p*-value	Odds (95% CI)	*p*-value
Onset of symptoms, day				
<10	References			
≥10	2.94 (1.009-8.61)	0.048	2.30 (0.33-15.97)	0.40
Leptomeningial enhancement	5.47 (1.52-19.67)	0.009	1.92 (0.25-14.36)	0.52
Deep seated brain abscess	2.66 (1.04-6.80)	0.04	1.45 (0.24-8.62)	0.68
Multiloculation	7.53 (2.77-20.44)	0.000	4.69 (0.80-27.42)	0.86
Number of brain abscess				
Single	References		References	
Multiple	3.50 (1.40-8.74)	0.007	4.55 (0.81-25.57)	0.08
Volume of brain abscess, ml				
<20	References			
≥20	4.48 (1.75-11.46)	0.002	3.35 (0.60-18.62)	0.16
Distant between brain abscess and ventricle, mm	0.55 (0.41-0.72)	0.000	0.62 (0.45-0.87)	0.005

IVROBA

In the literature, a few studies described IVROBA. The incidence of IVROBA reported varies from 30 to 36%[7,20]. The trend of IVROBA is fatal complications and poor prognostic factors[7,8,20]. However, discordance of the results was demonstrated in multivariate analysis[5]. The authors found IVROBA as a potential factor associated with an unfavorable outcome and mortality. The brain abscesses, which have a risk of intraventricular rupture, should be surgically treated before rupture. Death after IVROBA occurs as a consequence of delay in surgical intervention[8,21].

The encapsulation of a brain abscess occurs initially on day 10 to 14 of the infection and complete capsule form is usually within two weeks[22,23]. The encapsulation has been reported to be more complete on the cortical side compared with the ventricle side. The brain abscess trends to rupture into the ventricle rather than into the subarachnoid space[20].

The IVROBA was defined originally with clinical sudden neurological deterioration and neuroimaging findings[8]. The authors observed that almost half of the patients with IVROBA did not have sudden deterioration and their clinical course was more prolonged than the other. In the present study, the diagnosis of IVROBA was focused on neuroimaging findings.

To our knowledge, the distance between the abscesses is a significant risk factor predicted to IVROBA[7,8]. In the present study, the brain abscesses that had a distance between the abscess and ventricle of more than 7 mm were less likely to IVROBA. These findings were from the study and were important surgical indication.

The strength of the present study involved more analyses in the detailed aspect of the distance between the abscess and ventricle that is significant to predict IVROBA. In summary, the authors recommend that in clinical practice, the abscesses located less than 7 mm near a ventricle need intervention before IVROBA. However, the study had limitations. It was a retrospective design. The small number of IVROBA patients limited the power of the investigation. The authors did not evaluate treatment strategy of IVROBA patients. Currently, the treatment strategy of IVROBA remains controversial. A few studies mention several treatment modalities including a combination of intrathecal and intravenous antibiotics[8], open craniotomy with lavage of the ventricle and intraventricular administration of gentamicin and intraventricular drainage[6,8,20,21] or endoscopic evacuation of intraventricular debris[24]. The treatment of IVROBA needs further investigation.

What is already known on this topic?

From previous studies, IVROBA is a fatal complication[6]. Furthermore, few studies cited that the distance between abscess and ventricle is a potential predictive factor of intraventricular rupture[7,8].

What this study adds?

To the best of the authors' knowledge, this study is the first report that proposes concrete indication to intervene IVROBA, which is the when distance between the brain abscess and the ventricle is less than 7 mm, surgical intervention is urgently indicated.

Acknowledgement

The authors would like to offer their special thanks to Nakornchai Phuenpathom and Sanguansin Ratanalert for their advice.

Potential conflicts of interest

None.

References

1. Kao PT, Tseng HK, Liu CP, Su SC, Lee CM. Brain abscess: clinical analysis of 53 cases. J Microbiol Immunol Infect 2003; 36: 129-36.
2. Lu CH, Chang WN, Lin YC, Tsai NW, Liliang PC, Su TM, et al. Bacterial brain abscess: microbiological features, epidemiological trends and therapeutic outcomes. QJM 2002; 95: 501-9.
3. Qureshi HU, Habib AA, Siddiqui AA, Mozaffar T, Sarwari AR. Predictors of mortality in brain abscess. J Pak Med Assoc 2002; 52: 111-6.
4. Tseng JH, Tseng MY. Brain abscess in 142 patients: factors influencing outcome and mortality. Surg Neurol 2006; 65: 557-62.
5. Xiao F, Tseng MY, Teng LJ, Tseng HM, Tsai JC. Brain abscess: clinical experience and analysis of prognostic factors. Surg Neurol 2005; 63: 442-9.
6. Zeidman SM, Geisler FH, Olivi A. Intraventricular rupture of a purulent brain abscess: case report. Neurosurgery 1995; 36: 189-93.
7. Lee TH, Chang WN, Su TM, Chang HW, Lui CC, Ho JT, et al. Clinical features and predictive factors of intraventricular rupture in patients who have bacterial brain abscesses. J Neurol Neurosurg Psychiatry 2007; 78: 303-9.
8. Takeshita M, Kawamata T, Izawa M, Hori T. Prodromal signs and clinical factors influencing outcome in patients with intraventricular rupture of purulent brain abscess. Neurosurgery 2001; 48: 310-6.
9. Engh JA, Mintz A, Kassam AB. Diffusion-weighted magnetic resonance imaging demonstrating intraventricular rupture of a cerebral abscess and subsequent therapeutic response. Surg Neurol 2008; 70: 526-30.
10. Dellinger RP, Levy MM, Rhodes A, Annane D, Gerlach H, Opal SM, et al. Surviving sepsis campaign: international guidelines for management of severe sepsis and septic shock: 2012. Crit Care

Med 2013; 41: 580-637.
11. Wilson JT, Pettigrew LE, Teasdale GM. Structured interviews for the Glasgow Outcome Scale and the extended Glasgow Outcome Scale: guidelines for their use. J Neurotrauma 1998; 15: 573-85.
12. Donato V, Papaleo A, Castrichino A, Banelli E, Giangaspero F, Salvati M, et al. Prognostic implication of clinical and pathologic features in patients with glioblastoma multiforme treated with concomitant radiation plus temozolomide. Tumori 2007; 93: 248-56.
13. Jiang JY, Gao GY, Li WP, Yu MK, Zhu C. Early indicators of prognosis in 846 cases of severe traumatic brain injury. J Neurotrauma 2002; 19: 869-74.
14. Siddiqui AA, Shah AA, Bashir SH. Craniocerebral aspergillosis of sinonasal origin in immuno-competent patients: clinical spectrum and outcome in 25 cases. Neurosurgery 2004; 55: 602-11.
15. Kourkoumpetis TK, Desalermos A, Muhammed M, Mylonakis E. Central nervous system aspergillosis: a series of 14 cases from a general hospital and review of 123 cases from the literature. Medicine (Baltimore) 2012; 91: 328-36.
16. Mylonakis E, Paliou M, Sax PE, Skolnik PR, Baron MJ, Rich JD. Central nervous system aspergillosis in patients with human immuno-deficiency virus infection. Report of 6 cases and review. Medicine (Baltimore) 2000; 79: 269-80.
17. Pongbhaesaj P, Dejthevaporn C, Tunlayadechanont S, Witoonpanich R, Sungkanuparph S, Vibhagool A. Aspergillosis of the central nervous system: a catastrophic opportunistic infection. Southeast Asian J Trop Med Public Health 2004; 35: 119-25.
18. Schwartz S, Ruhnke M, Ribaud P, Reed E, Troke P, Thiel E. Poor efficacy of amphotericin B-based therapy in CNS aspergillosis. Mycoses 2007; 50: 196-200.
19. Pellacchia V, Terenzi V, Moricca LM, Buonaccorsi S, Indrizzi E, Fini G. Brain abscess by mycotic and bacterial infection in a diabetic patient: clinical report and review of literature. J Craniofac Surg 2006; 17: 578-84.
20. Ferre C, Ariza J, Viladrich PF, Acebes JJ, Tubau F, Lopez L, et al. Brain abscess rupturing into the ventricles or subarachnoid space. Am J Med 1999; 106: 254-7.
21. Isono M, Wakabayashi Y, Nakano T, Fujiki M, Mori T, Hori S. Treatment of brain abscess associated with ventricular rupture—three case reports. Neurol Med Chir (Tokyo) 1997; 37: 630-6.
22. Britt RH, Enzmann DR, Yeager AS. Neuropathological and computerized tomographic findings in experimental brain abscess. J Neurosurg 1981; 55: 590-603.
23. Enzmann DR, Britt RH, Yeager AS. Experimental brain abscess evolution: computed tomographic and neuropathologic correlation. Radiology 1979; 133: 113-22.
24. Nishizaki T, Ikeda N, Nakano S, Sakakura T, Abiko M, Okamura T. Successful neuroendoscopic treatment of intraventricular brain abscess rupture. Clin Pract 2011; 1: e52.

ปัจจัยทำนายผลการรักษาและการแตกเข้าโพรงสมองของฝีในสมอง

ธาราณ์ ตันธนาธิป, คเณศ กาญจนประดิษฐ์, ศักดิ์ชัย แซ่เฮ้ง, ฐากูร เอี้ยวสกุล, อิทธิชัย ศักดิ์อรุณชัย

วัตถุประสงค์: *เพื่อศึกษาปัจจัยที่ทำนายผลของการรักษาโรคฝีในสมองและเพื่อศึกษาปัจจัยที่ทำนายการแตกเข้าโพรงสมองของฝีในสมอง*

วัสดุและวิธีการ: *เป็นการศึกษาทบทวนย้อนหลังเวชระเบียนของผู้ป่วยจากฐานข้อมูลเครื่องสมองกล ระหว่าง พ.ศ. 2542 ถึง พ.ศ. 2556 ที่รับการรักษาเป็นผู้ป่วยในโรงพยาบาลตติยภูมิ และทำการวิเคราะห์แบบตัวแปรเดี่ยวและพหุปัจจัย เพื่อหาปัจจัยที่ทำนายผลการรักษาและการแตกเข้าโพรงสมองของฝีในสมอง*

ผลการศึกษา: *ผู้ป่วย 114 ราย ในการศึกษานี้ ปัจจัยที่ทำนายต่อผลการรักษาที่ดี ได้แก่ คะแนนกลาสโกว์ 13-15 (OR 14.64; 95% CI 2.70-79.34; p = 0.02) ในทางตรงกันข้าม ปัจจัยที่ทำนายต่อผลการรักษาที่ไม่ดี ได้แก่ ฝีในสมองชนิดเชื้อรา (OR 40.81; 95% CI 3.57-466.49; p = 0.003) และการแตกเข้าโพรงสมองของฝีในสมอง (OR 5.50; 95% CI 1.34-22.49; p = 0.017) นอกจากนี้ การเพิ่มขึ้นของระยะห่างระหว่างฝีกับโพรงสมองยิ่งลดโอกาสการเกิดการแตกเข้าโพรงสมองของฝีอย่างมีนัยสำคัญทางสถิติ (OR 0.62; 95% CI 0.45-0.87; p = 0.005) และพบว่าผู้ป่วยทุกรายที่มีการแตกเข้าโพรงสมองมีระยะห่างระหว่างฝีกับโพรงสมองน้อยกว่า 7 มิลลิเมตร (p<0.000)*

สรุป: *ผลการรักษาฝีในสมองนั้น ขึ้นกับปัจจัยต่าง ๆ ได้แก่ สภาพทางคลินิกของผู้ป่วยในระดับที่ดี ชนิดของเชื้อโรค และการแตกเข้าโพรงสมองของฝีในสมอง ซึ่งหากมีปัจจัยใดที่สามารถป้องกันไม่ให้เกิดขึ้นได้ ปัจจัยนั้นเป็นข้อบ่งชี้ที่สำคัญในการพิจารณารักษา*