

Clinical Features and Surgical Treatment of Bacterial Brain Abscess

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Objective : This study was performed to review the clinical characteristics and operative results of brain abscess in order to define the therapeutic strategy for this disease.

Methods : We reviewed the medical records and radiology images of brain abscess patients treated in our hospital during the last 16 years. A total of 35 cases included 23 males and 12 females, with the mean age of 48 years old. We excluded cases of postoperative, post traumatic, and fungal abscess. All patient underwent at least one surgical treatment such as stereotactic aspiration or craniotomy with excision.

Results : Twenty seven (77.1%) patients presented with symptoms of increased intracranial pressure. The frontal lobe was the most common anatomical place, and streptococcal species were the most frequently encountered pathogens. The chronic pulmonary diseases and chronic otitis media are common underlying condition. Eighteen patients underwent stereotactic aspiration and 17 patients had excision of their abscess as an initial treatment. Seven patients had a repeated surgery, 6 of them had been treated with aspiration initially. At discharge, 60.0% patients showed a favorable outcome.

Conclusion : The stereotactic drainage would be more suitable for the brain abscess located in deep and eloquent area. A large, solitary, and well-encapsulated lesion of superficial location could be best treated with complete excision, and this procedure was more definite because it is associated with less repeated surgery and showed more favorable outcome compared to aspiration surgery.

KEY WORDS : Bacterial brain abscess · Stereotactic aspiration · Excision · Outcome.

Introduction

There are remarkable improvement with respect to diagnosis and management of brain abscess, resulting in a corresponding increase of survival rates. However, its incidence is constantly high, approximately 5% per million people, and the number of immuno-deficient hosts having high risk of opportunistic infections might be increasing, this disease still continues to be one of the most important neurosurgical diseases^{4,13}.

In order to manage the patients of cerebral abscess successfully, the infectious process is to be eliminated with appropriate antimicrobial agent and mass effect should be reduced using drainage or excisional procedure, thus avoiding or minimizing a secondary cerebral injury and neurological deficit. The aim of this retrospective analysis was to document the etiology,

clinical presentation, bacteriological feature, operative methods, and treatment outcomes of bacterial brain abscess.

Materials and Methods

The subject of our study were 35 patients diagnosed as brain abscess and treated by antibiotics and appropriate surgical treatments in our hospital from January 1990 to December 2005. These included 23 males and 12 females. Their ages ranged from 8 years to 80 years, with a mean age of 48 years. Patients with evidence of brain abscesses not due to bacterial pathogens were excluded from this study. We also excluded post-craniotomy or traumatic brain abscess cases. All cases were done by retrospective analysis of the hospital records and radiology data. All patients were analyzed regarding the following factors : sex and age, location of brain abscess,

• Received : March 7, 2007 • Accepted : April 22, 2007

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initial consciousness level, symptoms and signs, predisposing factors, laboratory data including peripheral white blood cell (WBC) counts, biological organism, surgical procedure and its outcome, complications, and cause of death. Image diagnostic tool contained enhancing computed tomography (CT) scan and / or magnetic resonance (MR) imaging. With the advanced MR imaging techniques, a total 19 cases of brain abscess which developed after 1996 could have been identified by a characteristic diffusion weight restriction as a typical hyperintense lesion. Serial weekly or biweekly CT or MRI scanning provided the necessary information on the response to therapy and aided in the timing of repeated surgery.

Surgical modality was resection by craniotomy and stereotactic aspiration. Empirical antibiotic treatment was started soon after diagnosis in all cases. As a rule, initial treatment for abscess consisted of antibiotics such as combination of ceftriaxone, metronidazole, aminoglycoside and recently used vancomycin. Parenteral antibiotics were generally given for four to eight weeks. The duration of antimicrobial therapy was decided on a case-by-case basis, but the following factors were major determinant; result of antibiotics susceptibility test, size of lesion, surgical method (excision or drainage), patient's treatment response as noted clinically and radiologically, and inflammatory laboratory parameters. C-reactive protein level were measured to assess the response to therapy recently. Corticosteroid was selectively given to 15 patients revealed severe brain edema or imminent brain herniation. According to the activities of daily living at discharge, we defined the outcome as favorable if the patient was independent or partially dependent. Otherwise, the patient was regarded as having a unfavorable outcome if the patient died during admission or was totally dependent²³. Follow-up periods were ranged from 10 months to 10 years.

Results

Symptoms of elevated intracranial pressure were the most common clinical feature, with 27 (77.1%) patients presenting headache, nausea and vomiting. Fever was checked only in 24.3% of patients. A leukocytosis was shown in 60.7% of total patients on admission routine chemistry. C-reactive protein levels were higher than normal range in 37.5% of patients. Neurological deficits such as hemiparesis, dysphasia, and visual disturbance were noticed in 8 (21.1%) patients. Seizure was the primary presenting symptom in 2 patients in whom lesions located on the temporal lobe. On admission, the majority of patients were alert (71.4%), while drowsy (17.1%) and stupor or coma patients (11.4%) were also occasionally met. The anatomical sites of brain abscess at

Table 1. Details of 35 patients with bacterial brain abscess

Characteristics	Number	Percent (%)
Underlying condition		
Contiguous spread		
Middle ear infection	5	14.3
Paranasal sinusitis	4	11.4
Cellulitis	1	2.9
Dental procedure	1	2.9
Hematogenous spread		
Chronic pulmonary infection	8	22.9
Congenital heart disease	3	8.6
Meningitis	2	5.7
Immunodeficiency	1	2.9
DM	2	5.7
None known	8	22.9
Location of abscess		
Frontal	9	25.7
Temporal	2	5.7
Occipital	4	11.4
Parietal	7	20.0
Basal ganglia	2	5.7
Thalamus	2	5.7
Cerebellum	5	14.3
Multiple	4	11.4
Isolated microorganism	20	57.1
Streptococcus species	7	20.0
Staphylococcus species	6	17.1
Pseudomonas species	3	8.6
Enterococcus species	1	2.9
Actinomyces species	1	2.9
Peptostreptococcus species	2	5.7
Negative culture	15	42.9
Surgical procedure		
Stereotactic aspiration	18	51.4
Craniotomy and excision	17	48.6

admission were varied. The most common site was frontal lobe (25.7%), following parietal lobe (20.0%). There were 4 cases of deep-seated area including basal ganglia or thalamus, and 5 cases showed cerebellar lesions. Single abscess was noted in 31 (88.6%) patients and multiple abscesses in 4 patients.

Twenty-six patients (74.3%) had predisposing factors, but no source of infection was identified in 9 patients. The most common underlying condition was chronic pulmonary infection (22.9%), and other condition included middle ear infection (14.3%), paranasal sinusitis (11.4%), and congenital heart disease (8.6%). Only one case who had been treated with chemotherapy for leukemia was compromised immunologically. In the 20 culture-positive patients, streptococcal species (20.0%) were the most frequently encountered pathogen, followed by staphylococcus (17.1%) (Table 1).

Stereotactic aspiration by burr hole was performed in 18

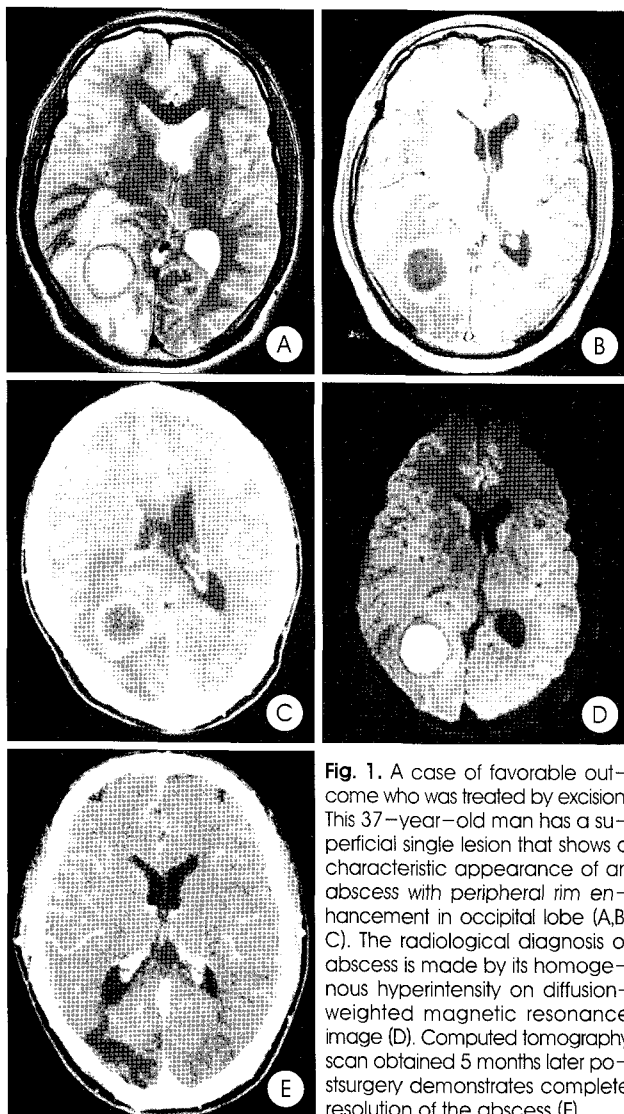


Fig. 1. A case of favorable outcome who was treated by excision. This 37-year-old man has a superficial single lesion that shows a characteristic appearance of an abscess with peripheral rim enhancement in occipital lobe (A,B, C). The radiological diagnosis of abscess is made by its homogeneous hyperintensity on diffusion-weighted magnetic resonance image (D). Computed tomography scan obtained 5 months later post-surgery demonstrates complete resolution of the abscess (E).

(51.4%) patients and craniotomy with excision accounted for 17 (48.6%) of the cases. During hospitalization, repeated surgery performed in 7 (18.4%) patients mainly in the aspiration group. Twenty-one (60.0%) patients were discharged with favorable outcome (Fig. 1). Among them, fifteen patients were treated with excision via craniotomy and only 6 were in the aspiration group. The other 8 (22.9%) patients were discharged with the remaining moderate to severe disability. Six (17.1%) patients died during hospitalization. The mortality of patients who underwent excision of abscesses was much lower than that of patient treated by aspiration (5.9% vs 27.7%). The majority of their cause of death was the aggravation of the underlying diseases such as sepsis, respiratory infection, hepatic failure, and heart failure (Fig. 2). The excision group had shown a shorter duration of intravenous antibiotic therapy compared to the aspiration group (4.5 weeks vs 5.8 weeks) (Table 2).

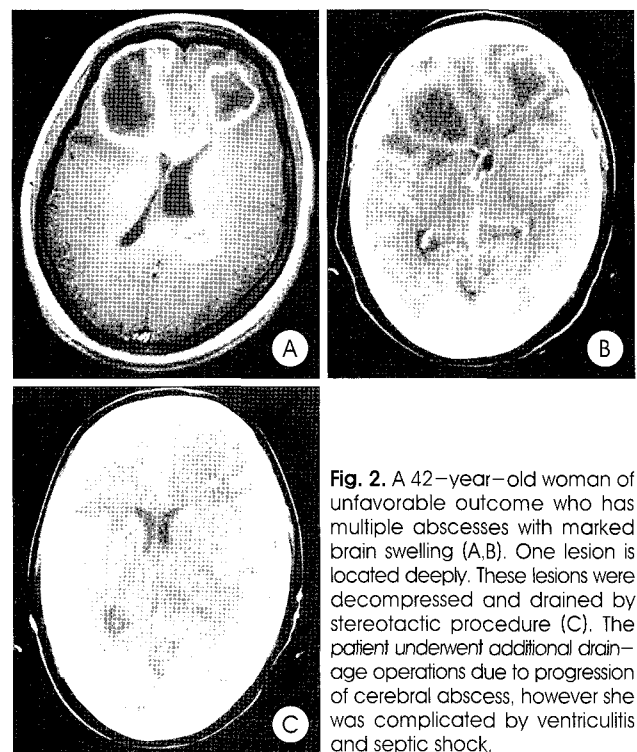


Fig. 2. A 42-year-old woman of unfavorable outcome who has multiple abscesses with marked brain swelling (A,B). One lesion is located deeply. These lesions were decompressed and drained by stereotactic procedure (C). The patient underwent additional drainage operations due to progression of cerebral abscess, however she was complicated by ventriculitis and septic shock.

Table 2. Results comparison between two surgical groups

	Aspiration (%)	Excision (%)
Mean age (yrs)	52.1	44.3
Male sex	13 (72.2)	7 (41.2)
Mean abscess size (cm)	3.4	3.5
Number of lesion		
Single	15 (83.3)	16 (94.1)
Multiple	3 (16.7)	1 (6.9)
Lesion location		
Superficial	14 (77.7)	17 (100)
Deep	4 (22.3)	0 (0)
Altered consciousness	6 (33.3)	4 (23.5)
Major medical illness	8 (44.4)	4 (23.5)
Antibiotics therapy (wks)	5.8	4.5
Repeated operation	6 (33.3)	1 (6.9)
Outcome		
Favorable	6 (33.3)	15 (88.2)
Unfavorable	12 (66.7)	2 (11.8)
Mortality (%)	5 (27.7)	1 (5.9)
Number of patients	18 (51.4)	17 (48.6)

Discussion

Patients suffering from the bacterial brain abscess frequently have causative disease or predisposing factor. The most common underlying condition was chronic pulmonary infection in this series as it occurred in 22.9% of patients. This large portion of pulmonary infection shown in our study was different from what others have shown their reports^{10,15}. This may be

due to the fact that we have many patients with chronic obstructive pulmonary disease in our country⁵⁾, and also we have excluded the cases of post operative and traumatic abscess. Another interesting point in the present study is the lesion location; the frontal being the most frequently developing place for brain abscess. This large proportion of frontal abscess might be arisen from direct resources such as cellulitis, sinusitis, and dental procedure.

The clinical presentation of intracranial abscess is dependant upon the site, size, number of lesions, and any secondary cerebral injuries. As shown in the literature¹¹⁾, our cases also were frequently presented with classical symptom triad of this disease such as headache, fever, and focal neurologic defects. This nonspecific clinical presentation accounts for the frequent delay in diagnosis and the difficulty in early distinguishing brain abscess from more common causes of headache. Nevertheless, with the advancement of MR technology including perfusion- and diffusion-weighted images and MR spectroscopy, more accurate diagnosis of cerebral abscess and differentiating from other ring-enhancing lesions has been possible^{2,3)}. As with other reports¹⁰⁾, 60% of our patients demonstrated a elevated white blood cell count on admission. Laboratory parameters such as erythrocyte sedimentation rate and C-reactive protein were useful indicators of clinical response to treatment, but not helpful in diagnosing brain abscess or in predicting outcome²³⁾.

Although there was a change in the relative frequency of isolated microorganism, gram-positive bacteria, especially viridan Streptococci, have remained the most prevalent pathogen of bacterial brain abscess from 1952 to recent days²³⁾. Our study also revealed that this streptococcal species was the most encountered pathogen (20.0%) followed only by staphylococcus (17.1%). With development of culture technique and microbiologic analysis, the trend is towarded to the high incidence of infection with polymicrobial and gram-negative organism in today's causative organism^{8,22)}. Emerging of methicillin-resistant Staphylococcus aureus (MRSA) is another worrying problem⁴⁾. In general, despite comprehensive investigation, no pathogenic source was found in approximately 20-30% of previous study. But, our study showed larger number of negative culture rates (42.9%). This may be because almost all patients had been started on pre-operative empiric antibiotics with antianaerobic activity and anti-MRSA, and delayed operation on the referring cases from another hospitals or non-neurosurgical departments. Our average delay in operation time from admission day was 2.5 days. According to the report on 102 bacterial abscess cases¹⁰⁾, the use of pre-operative antibiotics was significantly associated with sterile cultures, so that the authors recommend preoperative antibiotics should not be administered when an operation can be performed

without delay.

For the patients with imminent brain herniation, multiple abscesses, and cerebellar brain abscess, corticosteroids may be cautiously used to reduce significant edema and mass effect because of their negative effects on the disease process and treatment outcome⁹⁾. Brain abscess is basically a surgical lesion. But, recently there have been a few reports demonstrating successful nonoperative treatment of brain abscess with antibiotics alone^{11,23)}. This approach may be appropriate for clinically stable patients who are poor candidates for surgery or for patients with surgically inaccessible but smaller and better-vascularized lesions. However, surgical treatment should be seriously considered if there is no clinical or radiological improvement in one to two weeks. Additionally, as a contrasting comment on nonoperative therapy, it is emphasized that the early diagnosis and prompt surgical approach act as the main factor of good result in the management of bacterial brain abscess patients¹¹⁾. Surgery allows the immediate lowering raised intracranial pressure from a mass effect and identification of the causative organism. Secondly, it also seems that surgical treatment by aspiration or excision is more likely to lead to a short treatment and decrease the possibility of serious clinical deterioration with intraventricular rupture.

In choosing between aspiration or excision, various factors including surgical morbidity, success rate, and sequela such as recurrence and seizure disorders also must be considered¹⁷⁾. With the availability of CT scans, the role of aspiration has increased, and the technique has a place not only as a preparatory to subsequent excision, but also as a definite procedure. With the use of stereotactic approaches, many reports have shown various advantages of the aspiration surgery of brain abscess, such as rapid and safe technique, processing with local anesthesia, diagnostic trial in suspected cases, intraoperative real-time guidance, use in emergency situation, multiple practice, and possible cure for a small-sized abscess^{6,14,16,21)}. The diminution of infected material with aspiration also has the potential for reducing the number of organism and the magnitude of the brain inflammatory response and reactive edema^{19,20)}. Moreover, drainage procedure can make abscess cavity shrunken in size, decreasing mass effect and allowing better penetration of antibiotics from the vascularized abscess capsule. Either once or repeatedly, the abscess aspiration is well suited for treating the patient with multiple lesions^{1,10,22)}. Contrary to the recent report advocating aspiration, our series showed that multiple abscess were not successfully treated with stereotactic aspiration alone. In this study, 3 of 4 cases of multiple abscess underwent aspiration alone resulting in 2 cases of death and 1 case who remained disabled. Furthermore, as shown in this study, it has been suggested that repeated operation is often necessary especially for the aspiration group than the resection group¹²⁾.

The appliance of double lumen catheter and hyperbaric oxygen therapy during the drainage procedure of abscess contributed to a remarkable aspiration rate and healing rate with lower recurrence respectively^{7,14}.

Abscess can be excised during late capsular state or after aspiration and draining procedure. There are two advantages of surgical excision : it has lower incidence of recurrence and allows complete recovery of patients after first operation¹³. There advantages were also experienced in our series. In 17 of initial excision group, only one case received a subsequent operation. Despite its efficacy on lesion cure, excision surgery may induce injury to peripheral normal tissue and neurosurgeon must wait for the stabilization of abscess wall for a long time while, at sometimes, unexpected danger can be induced in case of rupture of abscess wall. Excision is inappropriate for deep seated abscesses in eloquent area and multiple lesions¹⁹. Recently, based on their good treatment outcome with craniotomy and lesionectomy, they recommended that indication for early surgical excision of brain abscess are single, accessible, superficial, and larger lesion accompanying aggravated neurological deficit¹³. Also, abscesses containing gas and multiloculated actinomycosis and nocardial abscess are better treated with excision because these are resistant to antibiotics and simple aspiration. The post-traumatic abscess containing foreign bodies or contaminated bony fragments requires excision to prevent recurrence^{11,17}.

Although there is no conclusive evidence that suggests superiority between aspiration and excision, comparing our two surgical results, it is evident that excisional surgery seems to be more superior to stereotactic aspiration, particularly with regards to good outcome, mortality, and revision surgery. The majority of the unfavorable outcome group underwent the stereotactic drainage initially, with or without following repeated drainage or excision through craniotomy. However, when comparing the outcome between two treatment groups, the following factors should be considered. First, the aspiration group may be associated with more multiple abscess, ventriculitis and poor general condition. Second, good surgical outcome in the excision group was probably related to better prognostic factors, general condition and more favorable location of abscess that could be excised completely by craniotomy. In general, it has been proven that the clinical outcome of brain abscesses is highly correlated to the initial neurological status^{4,15,18}. In this study, 81.8% of the well improved cases were alert at admission, but the conscious level at presentation was varied in the poor outcome group. Other reports showed the presence of septic shock significantly influenced the outcome of the brain abscess and the outcome is poorer and the mortality is higher for immunocompromised patients^{8,23}. Our mortality rate suggests that the aggravation of the systemic illness or

underlying diseases is more responsible for the patient's death than brain abscess itself.

Conclusion

Bacterial brain abscess is commonly encountered focal infectious lesion that need to be treated surgically. Abscess located in deep and eloquent areas and multiple lesion can be effectively aspirated by stereotactic approach. With less repeated surgery and more favorable outcome compared to aspiration group, an excisional surgery would be a more definite treatment for the large, superficial, and single encapsulated lesions.

References

1. Basit A, Ravi B, Banerji AK : Multiple pyogenic brain abscesses : an analysis of 21 patients. *J Neurol Neurosurg Psychiatry* 52 : 591-594, 1989
2. Cartes-Zumelzu FW, Stavrou J, Castillo M, Eisenhuber E, Knosp E, Thurnher MM : Diffusion-weighted image in the assesment of brain abscess therapy. *AJNR Am J Neuroradiol* 25 : 1310-1317, 2004
3. Ferreira N, Ota GM, Amaral L, Rocha AJ : Imaging aspect of pyogenic infections of the central nerve system. *Top Magn Reson Imaging* 16 : 145-154, 2005
4. Jeon SR, Kim JH, Ra YS, Roh SW, Kim CJ, Kwon Y : Analysis on surgical outcome of brain abscess. *J Korean Neurosurg Soc* 28 : 1131-1136 : 1999
5. Kim DS, Kim YS, Jung KS, Chang JH, Lim CM, Lee JH : Prevalence of chronic obstructive pulmonary disease in Korea : a population-based spirometry survey. *Am J Respi Crit Care Med* 172 : 842-847, 2005
6. Kim HW, Kim JH, Jung S, Kim SH, Kang SS, Lee JH : Stereotaxy in brain abscess. *J Korean Neurosurg Soc* 26 : 320-325, 1997
7. Kutlay M, Colak A, Yildiz S, Demircan N, Akin ON : Sterotaxic aspiration and antibiotic treatment combined with hyperbaric oxygen therapy in the management of bacterial brain abscesses. *Neurosurgery* 57 : 1140-1146, 2005
8. Lu CH, Chang WN, Lin YC, Tsai NW, Liliang PC, Su TM : Bacterial brain abscess : microbiological features, epidemiological trends and therapeutic outcomes. *QJ Med* 95 : 501-509, 2002
9. Mamelak AN, Mampalam TJ, Obana WG, Rosenblum ML : Improved management of multiple brain abscesses : a combined surgical and medical approach. *Neurosurgery* 36 : 76-86, 1995
10. Mampalam TJ, Rosenblum ML : Trends in the management of bacterial abscesses : a review of 102 cases over 17 years. *Neurosurgery* 23 : 451-458, 1988
11. Mathisen GE, Johnson JP : Brain abscess. *Clin Infect Dis* 25 : 763-781, 1997
12. Ng PY, Sewo WT, Ong PL : Brain abscesses : review of 30 cases treated with surgery. *Aust N Z J Surg* 65 : 664-666, 1995
13. Park DH, Lee SH, Lee KS, Chung UW, Park KH, Lee YW : Clinical features and surgical results of brain abscesses. *J Korean Neurosurg Soc* 37 : 208-271, 2005
14. Park JH, Yoo DS, Kim DS, Huh PW, Cho KS, Kang JK : Continuous irrigation of brain abscess using a double lumen catheter. *J Korean Neurosurg Soc* 29 : 1328-1322, 2000
15. Roche M, Humphreys H, Smyth E, Philips J, Cunney R, McNamar E, et al : A twelve-year review of central nervous system bacterial abscesses; presentation and aetiology. *Clin Microbiol Infect* 9 : 803-809, 2003
16. Shahzadi S, Lozano AM, Bernstein M, Guha A, Taker RR : Stereotaxic management of bacterial abscesses. *Can J Neurol Soc* 23 : 34-39, 1996
17. Sharma BS, Gupta SK, Khosia VK : Current concepts in the management of pyogenic brain abscess. *Neurol India* 48 : 105-111, 2000
18. Sichizya K, Fleggen K, Taylor G, Jonathan P : Brain abscesses - the Groote Schuur experience, 1993-2003. *South African J Surg* 43 : 79-82, 2005

19. Stephanov S : Surgical treatment of brain abscess. *Neurosurgery* 22 : 724-730, 1988
20. Stephanov S, Joubert MJ : Large brain abscesses treated by aspiration alone. *Surg Neurol* 17 : 338-340, 1992
21. Strowitzki M, Schwerdtfeger K, Steudel WI : Ultrasound-guided aspiration of brain abscesses through a single burr hole. *Minim Invas Neurosurg* 44 : 134-140, 2001
22. Tsai JC, Teng LJ, Hsueh PR : Direct detection of bacterial pathogens in brain abscess by polymerase chain reaction amplification and sequencing of partial 16s ribosomal deoxyribonucleic acid fragments. *Neurosurgery* 55 : 1154-1162, 2004
23. Xiao F, Tseng MY, Teng LJ, Tseng HM, Tsai JC : Brain abscess : clinical experience and analysis of prognostic factors. *Surg Neurol* 63 : 442-450, 2005

Commentary

In the 35 brain abscess patients, the most common underlying condition was chronic pulmonary infection. The streptococcal species (20.0%) were the most frequently encountered pathogen, followed by staphylococcus. However, the selection of antibiotics based on the available culture and susceptibility

results was not documented on this paper.

Less invasive aspiration by burr hole and craniotomy have been performed in the half and half of the patients, however, the repeated surgery was needed in 18.4% patients in the aspiration group. So, the surgical treatment methods should be decided upon the patient's clinical status, the neuroradiographic characteristics of the abscess, and the experience of the surgeons who will be carrying out the procedure¹⁾.

This paper is well designed retrospective study for the clinical, laboratory finding, and the management of brain abscess.

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Reference

1. Lu CH, Chang WN, Lui CC : Strategies for the management of bacterial brain abscess. *J Clin Neurosci* 13 : 979-985, 2006