CLINICAL RESEARCH

Brain Abscesses: Review of 97 Cases

Beyin Abseleri: 97 Olgunun İncelenmesi

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Abstract: Ninety seven cases of brain abscess, diagnosed between January 1984 and January 1996, are reviewed. The most common cause was direct spread of infection from neighbouring structures. Signs of increased intracranial pressure were present in most cases, and clinical signs of infection were seen in only 41 patients. The patients were grouped according to the treatment they received: Excision (n = 25), aspiration (n = 58), excision following aspiration (n = 14). The predominant strains were Staphylococcus aureus and Streptococcus sp. In 16 patients who were treated with antibiotics preoperatively, no bacteria was identified. The mortality rate was 6 %. The patients' discharge status from the hospital was good or moderate in 89,6 % of aspiration group and in 71,8 % of excision group. The discharge status from the hospital was bad in 7 of 13 patients who were unconscious preoperatively.

Key Words: Bacterial infection, brain abscess, surgical therapy

Özet: Ocak 1984 ve Ocak 1996 arasında tanı konan 97 beyin absesi olgusu değerlendirildi. En sık görülen sebep infeksiyonun komşu yapılardan doğrudan yayılımıydı. Kafa içi basınç artışı bulguları olguların çoğunda bulunurken infeksiyon bulgularına yalnız 41 olguda rastlandı. Hastalar uygulanan tedaviye göre gruplandırıldı: Eksizyon (n = 25), aspirasyon (n = 58), aspirasyon ardından eksizyon (n = 14). En sık üreyen bakteriler Staphylococcus aureus ve Streptococcus türleri oldu. Ameliyat öncesi antibiyotik ile tedavi edilen 16 hastada bakteri üretilemedi. Ölüm oranı % 6 idi. Hastaneden çıkış durumu aspirasyon grubunun % 89,6'sında, eksizyon grubunun ise % 71,8'inde iyi veya orta oldu. Ameliyat öncesi şuur kaybı olan 13 hastanın yedisinde hastaneden çıkış durumu kötüydü.

Anahtar Sözcükler: Bakteriyel infeksiyon, beyin absesi, cerrahi tedavi

INTRODUCTION

A brain abscess is a localized suppurative process within the brain parenchyma caused by a wide variety of bacteria, fungi, and protozoa. Despite the widespread use of antibiotics and improved living standards, the incidence of brain abscess does not appear to be changing (9,16). In fact, Samson and Clark suggested that the incidence may actually be rising due to the rapidly increasing incidence of opportunistic infections in immunocompromised hosts (21).

There have been many reports on the surgery and treatment of brain abscess. The French surgeon Morand (14) is credited with being the first neurosurgeon to successfully drain an intracerebral abscess over 200 years ago, using his finger to break down the capsule. In 1926, Walter Dandy advocated simple aspiration through a burr hole (6). A more aggressive approach of total excision of brain abscess was advocated by Vincent in 1936 (23). The controversy between surgical excision and aspiration still persists today.

This paper reports 97 cases of brain abscess surgically treated in the Neurosurgery Department of Cerrahpaşa Medical Faculty of İstanbul University.

MATERIALS AND METHODS

Over the period from January 1984 to January 1996, 97 cases of bacterial brain abscess were surgically treated at the Neurosurgery Department of Cerrahpaşa Medical Faculty of İstanbul University. These abscesses constituted 2,6% of 3744 intracranial space occupying lesions diagnosed during the study period. There were 72 males and 25 females, ranging in age from 2 months to 69 years (mean 24 years). Thirty patients were under 15 years of age.

All cases of others intracranial suppuration, such as subdural and extradural empyema were excluded. Parasitic or fungal intracranial suppurative infections were also excluded in order to create an uniform series of bacterial brain abscesses. But, cases of sterile abscesses were considered in this study.

For each patient, presenting features, preoperative neurological status, predisposing factors or concurrent illness, site of abscess, organisms isolated were recorded.

The treatment modality consisted of primary craniotomy in 25 patients, single burr hole aspiration in 9 patients, multiple burr hole aspiration in 49 patients, puncture and aspiration and secondary craniotomy in 14 patients. In 6 pediatric cases which were treated by aspiration alone, needle aspiration of the abscesses was done percutaneously, without making a burr-hole.

The results were classified as good, moderate or bad. We classified patients with no neurological abnormality after treatment in the group with good results. Patients with a moderate result had some neurological signs after treatment but were able to take care of themselves, patients who needed someone else to take care of them were placed in the bad group. The patients were followed-up every 3 months for 1 year after the treatment, and the follow-up periods were delayed if there was no contrast enhancement in the last computerized tomography (CT) scans. The average length of follow-up was 16 months.

RESULTS

Signs and Symptoms

On admission to the hospital, the signs were general and focal. Fever and/or leukocytosis were present in 42 % of the cases. Neurological signs were related to the abscess location, side and edema. Signs of increased intracranial pressure (ICP), headache, vomiting and nausea were present in 74 cases; 17,5 % of patients were in coma at admission (Table I).

Etiology and Localization

The underlying source of infection was identified in 86 patients, and in 60 patients, the brain abscess aroused as a result of direct spread of infection from neighboring structures (Table II). Cyanotic congenital heart disease was the predominant cause of hematogenous spread. Nine

Table I: Symptoms and Signs in 97 Cases of Brain Abscess

Symptoms and signs	Number of cases
Increased ICP	74
Motor weakness	41
Infection signs	41
Visual impairment	21
Epilepsy	18
Unconsciousness	17

Table II: Etiological Factors in 97 Cases of Bacterial Brain Abscess

Etiology	Number of cases	
Direct spread	60	
Ear infections		24
Meningitis		10
Postoperative		8
Posttraumatic		6
Scalp infections		4
Cranial osteomyelitis		3
Dental infections		2
Paranasal sinusitis		1
Tonsillar abscess		1
Intraventricular puncture		1
Hematogenous	26	
Congenital heart disease		12
Suppurative lung disease		8
Sepsis		6
Unknown	11	

of these patients were children and 3 were young adults. Eleven patients had no identifiable predisposing cause.

Location of the abscesses were governed by the etiology, and the parietal and temporal lobes were the areas most often affected (Table III). In 7 patients, CT or magnetic resonance imaging (MRI) scans showed 2 to 7 abscesses, all of them caused by hematogenous spread.

Table III: Locations of Brain Abscesses

Location	Number of cases*
Parietal	37
Temporal	32
Frontal	27
Occipital	14
Cerebellar	9

* Including 7 cases of multiple abscess

Diagnosis and Bacteriology

For the diagnosis of an abscess and its localization, CT or MRI scans were used. In the majority of cases, abscess appeared on CT scans as a ring-enhancing lesions. In MRI, T1-weighted images showed characteristically a peripheral zone of mild hypointensity relative to adjacent brain representative of edema formation that surrounds a central region of more marked signal hypointensity indicative of the necrotic center of the abscess. These two regions were separated by the capsule that appears as a discrete rim that is iso- to mildly hyperintense. On T2-weighted sequences, the signal intensity of the zone of edema increased markedly compared to the adjacent brain while the central core was iso- to hyperintense compared to gray matter (Figure 1)

In 16 patients, no bacteria was identified and the abscesses were considered to be therefore sterile. The predominant strains were Staphylococcus aureus and Streptococcus sp. Multiple organisms were identified in 15 patients. Table IV lists the types of bacteria found in the abscesses in this series. Thirtytwo patients were treated preoperatively with antibiotics. All 16 sterile abscesses were treated preoperatively with antibiotics. Modern methods for the study and identification of anaerobic bacteria have improved so that, in comparison with former times, we see fewer sterile abscesses.

Table IV: Bacteriological Results in 97 Cases of Brain Abscess

Microorganisms	Number of cases
Gram (+)	28
Gram (-)	22
Multiple	15
Anaerobe	16
No organism	16

Methods of Treatment and Results

In 72 cases, the first surgical procedure was aspiration of the abscess through a burr hole (Table V). Six pediatric cases, under 4 years of age, were treated by percutaneous puncture of the abscess cavity without making a burr-hole. In 3 of these cases, puncture of the abscess cavity was done through the bregmatic fontanel, but in 3 with closed fontanels, abscess cavity is entered through the bone, by using a 16 gauge lumbar puncture needle as a twist drill. In 16 of these 72 cases, treatment continued with repeated aspirations (Figure 2). In 14 patients, aspiration was unproductive to begin with, or continued aspiration failed to control the abscess. In these cases, total excision was carried out. Excision was the primary procedure in 25 cases. Three of them were misdiagnosed as a glial tumor preoperatively. In addition to surgery, all patients were treated with broad spectrum antibiotics administered intravenously. The mean duration of intravenous antibiotic therapy was 5 weeks after total excision and 8 weeks after aspiration. Almost all patients initially received penicillin-chloramphenicol or ceftriaxon-gentamicin. Antibiotics were changed appropriately after the culture and susceptibility results became available. Treatment of the site of the primary infection was carried out as soon as the patient's neurological status stabilized. Multiple abscesses were treated by aspiration of the greatest

Table V: Treatment Methods in 97 Cases of Bacterial Brain Abscess

Operations	Number of cases	
Total excision	25	
Burr Hole aspiration	58	
single		9
multiple		49
Excision following aspiration	14	

abscess in cases of mass effect with herniation, failure to resolve or progression of abscesses during follow-up examinations. In some cases, aspiration of multiple abscesses through a simple burr hole has been possible. Adjoining corticotherapy was administrated only in patients with progressive neurological deterioration and radiological confirmation that the abscess has caused significant cerebral edema and mass effect. Eighteen patients, who had seizures preoperatively, received antiepileptic treatment. No prophylactic antiepileptic therapy was given preoperatively. Only 4 patients developed seizures postoperatively.

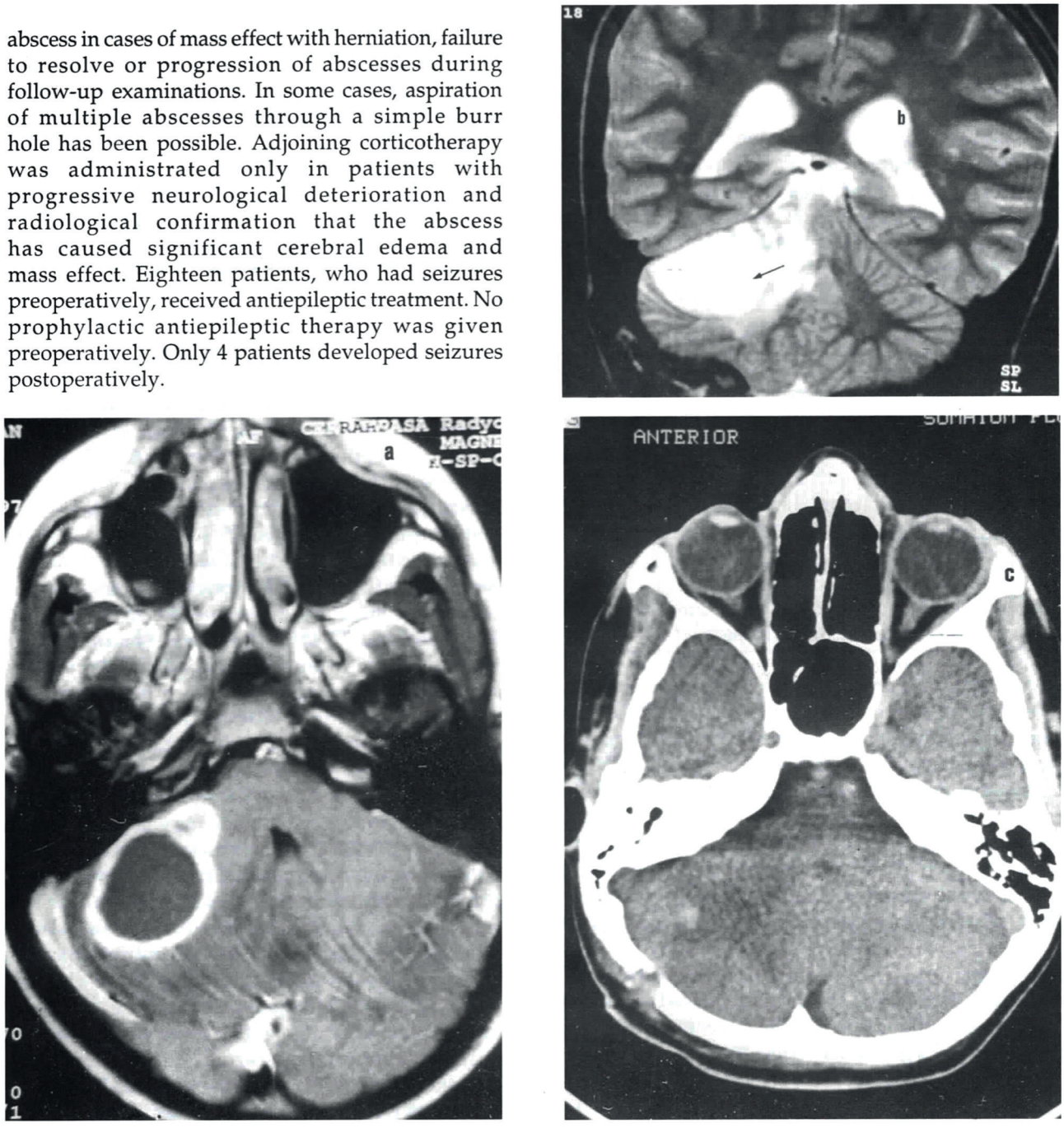

Figure 1: a) T1 weighted axial MRI scan shows an otogenic brain abscess in the cerebello-pontine angle. The capsule enhances markedly with the contrast, b) In T2 weighted coronal images, peripheral edema and necrotic center of abscess are seen hyperintense compared to gray matter. Between the zone of edema and necrotic center, the capsule can be visualized (arrow), c) CT scans with contrast shows that the abscess cavity and capsule have completely disappeared after single burr-hole aspiration.

For all these treatment methods, the overall mortality rate was 6 %. Four patients who died after surgery were in coma preoperatively. In one patient, abscess ruptured into the ventricle during excision. Another patients deteriorated abruptly with signs of brain herniation, during the course of treatment by repeated aspiration. For the remaining 13 patients who were unconscious preoperatively, the discharge status were bad in 7 cases, moderate in 6 cases. The patients' discharge status from the

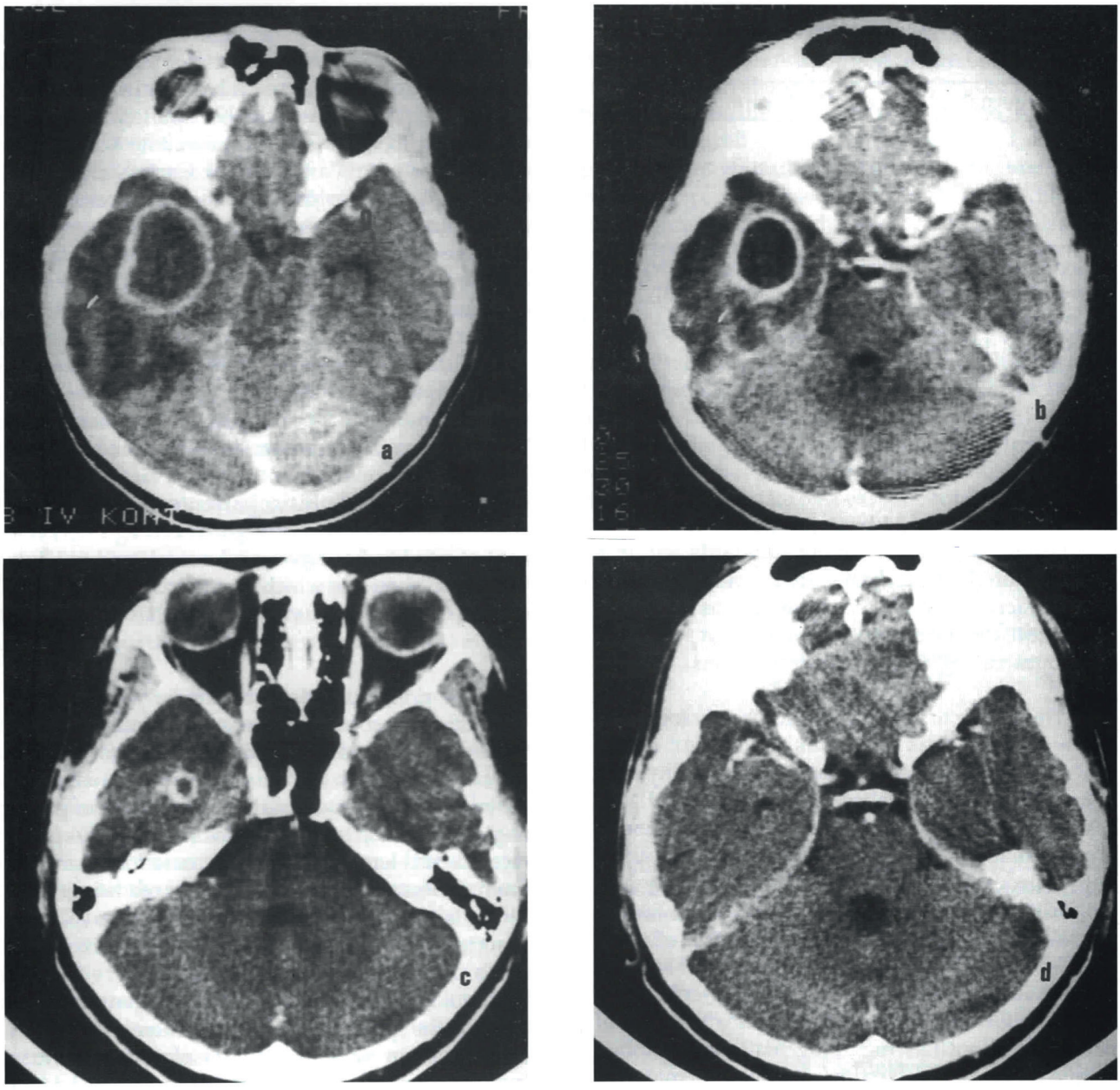

Figure 2: Serial CT scans of a case of temporal abscess, a) temporal abscess with peripheral edema before treatment, b) after the first aspiration the size of the abscess was decreased, c) after the second aspiration the abscess cavity was decreased markedly, but there is still small abscess with rim enhanced capsule, d) the treatment continued with antibiotics, and there is no abscess in CT scan with contrast performed 1 year after the treatment.

hospital were good or moderate in 89,6 % of aspiration group and in 71,8 % of excision group (Table VI).

A ventriculo-peritoneal shunt was inserted in 6 patients because of communicating hydrocephalus, 1 week to 14 months after treatment. At long term follow-up, a 54-year old male patient with paranasal sinusitis and a 14-years old girl with congenital heart disease developed second abscesses 3 and 4 years after the treatment of their abscesses, respectively. They were treated successfully by repeated aspiration. Four patients died of causes unrelated to their brain abscesses 2 to 5 years after discharge.

Table VI: Relationship Between Results and Treatment Methods

Discharge status*	Excision**	Aspiration***	Total
Good	10	16	26
Moderate	18	36	54
Bad	7	4	11
Exitus	4	2	6

* Good: No or minor neurologic deficit. Moderate: With neurologic deficit but is able to live independently. Bad: Unable to perform daily activity, bedridden.
** Including primary and secondary excisions
***Including single and multiple aspirations

DISCUSSION

The incidence of brain abscess depends on geographic location and living standards within a given region. In India, brain abscess comprised 8 % of all intracranial space-occupying lesions (2). At our institution, the incidence of brain abscess was 2,6 % of all intracranial space-occupying lesions.

The failure to identify and accurately localize a brain abscess was previously a major factor contributing to the high morbidity and mortality rates associated with brain abscess (15,17). CT and MRI have allowed earlier, more accurate identification of brain abscess and have thus contributed immeasurably to the reduction in mortality and morbidity compared to the pre-CT era (17). Our 6 % mortality rate was significantly low compared those of 27-53% rate of pre-CT era (5,9,12,13). The differential diagnosis of a solitary ring-enhancing lesion on CT or MRI scans includes a number of pathological entities including malignant glioma, metastatic tumor, infarction, resolving hematoma, and radiation necrosis. Location at the cortico-medullary junction, multiloculation, multiplicity, leptomeningeal or ependymal enhancement are findings that favor a diagnosis of abscess (24). Three cases in our series were misdiagnosed as a glial tumor preoperatively.

The major underlying source of brain abscesses was direct spread of infection from the neighboring structures. But, as in many series, we have found a higher incidence of congenital heart disease in pediatric cases (8,11,22).

The only obvious prognostic factor to emerge in this review was the patient's level of consciousness at the time of operation. The observation of a stepwise increase in mortality with deeper levels of disturbance of consciousness has been a consistent finding in series in which the problem has been considered (5,9,16). The mortality rate was found consecutively 72 % and 89 % by Garfield et al. and Carey et al. (5,9), for patients who are unresponsive at the time of operation. The size of the abscess was reported by Mampalam et al. as an other factor contributing to outcome (15). No such remark was concluded from our observation.

Although the source of infection is frequently apparent, it is reported that the definitive cause remains obscure in 10 to 37 percent of patients (14). This was similar in our series. When the source of infection is considered in terms of associated mortality or morbidity, patients with cyanotic congenital heart disease or chronic lung infections are reported to have poorer survival, and patients with brain abscesses which occur secondary to direct spread from adjacent structures to have the better results (13,15,22).

The predominant strains, in the present series were Staphylococcus aureus and Streptococcus sp. Some studies of brain abscess reported relatively few infections caused by gram-negative organisms (7). However, some series found the incidence of gram-negative infection to be as high as 22 percent (9). More recent series have shown an increased incidence of brain abscesses caused by anaerobic organisms (1,10). There is also a high incidence of sterile cultures reported in the literature (15,25). This was likely due in large measure, to the inadequacy of the bacteriological procedures employed that could not support the growth of fastidious microbes. In 16 of our cases, no organism was isolated. This may indicate successful antibiotic therapy before aspiration, or the major organism may have been anaerobic and would not have been isolated by the methods then in use. In these circumstances, it seems reasonable to continue the original antibiotic regime, unless it becomes evident that it is not effective. Mampalam et al. (15) suggested that the use of preoperative antibiotics was significantly correlated with the occurrence of sterile cultures, but, De Louvois et al. (7) reported that, with meticulous microbiological techniques, positive cultures can be obtained in virtually 100 percent of brain abscesses even in the face of antibiotic therapy.

Once a brain abscess is diagnosed, its treatment has three components: the administration of

antibiotics, the drainage of pus or the excision of the abscess, and the treatment of the primary focus of infection. Surgical treatment is recommended for abscesses larger than 3 cm in diameter by Mampalam et al. (15). We think that operation remains the definitive treatment for almost all brain abscess. A reasonable candidate for medical therapy is the patient with multiple abscesses (4,18). We operated 7 cases of multiple brain abscesses because they were life-threatening symptomatic abscesses. CT-guided stereotactic techniques, which minimizes the risks of surgery can be used for these selected patient, also for small abscesses, particularly in eloquent brain locations. Aspiration will confirm the diagnosis of brain abscess and avoid the occasional antibiotic treatment of other masses, such as malignant tumors, cysts and resolving hematomas, that can resemble brain abscesses on radiological evaluation (19). In some pediatric cases, single or multiple percutaneous needle aspiration can be a simple alternative to the burr-hole aspiration if the abscess is located superficially. The passage through the bone is easily done by using the needle as a twist drill.

A causative organism was identified from most of the surgical specimens in this series; this information was valuable in selecting antibiotic regimens. In contrast, a causative organism could be presumed from cultures of blood or other body fluids in only a minority of the nonsurgically treated patients. Whether aspiration or excision of the abscess is in general the better course is a still controversial issue. The advantages of aspiration are that it is simple, can be used in the early stages, and may give swift relief of increased intracranial pressure. Its risks are that it may allow the abscess to rupture into the ventricle, or pus may leak into the subarachnoid space, with the risk of ventriculitis or meningitis. It may fail when there are foreign bodies or bone fragments in the cavity, or if there are multiple loculi. Antibiotic solutions used for irrigating may leak into surrounding tissue and may precipitate early epilepsy (3). In some cases, craniotomy was carried out and the abscess excised. In the acute stage, this was done if there were signs of tentorial herniation, if the abscess had ruptured into the ventricle, or if little pus had been obtained by aspiration and the intracranial pressure remained high. In the chronic stages, the indications for excision were the presence of foreign bodies such as bone fragments in the abscess, the development of multiple loculi or the finding of a persistently high volume of pus at repeated aspirations. When possible, excision was delayed until a definite capsule had formed. The use of corticosteroids in the treatment of cerebral abscess was not recommended exclusively (15). Animal studies of brain abscess suggested that the potential benefit of reducing cerebral edema may be counterbalanced by its adverse effects on antibiotic penetration, immune response of the host and collagen capsule deposition (20,26). We advocate the use of corticosteroids to arrest progressive neurological deterioration in combination with suitable antibiotics (20).

In summary, due to low morbidity and morbidity, we recommend burr hole aspiration as a treatment of choice in cases of bacterial brain abscesses. In recurrent cases, multiple aspiration may be tried. The primary source should be treated as soon as the patient's neurological status stabilize. Antibiotic therapy for 5 weeks after total excision and 8 weeks after aspiration is recommended.

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