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Brain Abscesses: Clinical Experience and Outcome of 52 Consecutive Cases

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Rezumat

Abcesele cerebrale: experienţa clinică şi prognosticul în 52 de cazuri consecutive

Introducere: Abcesele cerebrale reprezintă încă o patologie cerebrală importantă, cu morbiditate şi mortalitate crescute, în ciuda progresului înregistrat de tehnicile imagistice şi antibioterapie. În acest studiu, am analizat relaţia dintre caracteristicile clinice, biologice şi terapeutice la internare şi prognosticul clinic al pacienţilor cu abcese cerebrale.
Material şi metodă: Acesta este un studiu retrospectiv pe o serie de 52 de pacienţi consecutivi cu abcese cerebrale trataţi în clinica noastră de neurochirurgie într-o perioadă de 8 ani, între ianuarie 2003 şi decembrie 2011. Au fost efectuate teste de laborator, examene CT şi RMN cerebrale, hemoculturi şi uroculturi. Tratamentul chirurgical a constat fie în stereotaxie ghidată tomografic, fie în craniotomie clasică cu rezecţia abcesului. Materialul obţinut din abcesul cerebral a fost însămânţat pe medii aerobe şi anaerobe. Tratamentul parenteral a avut o durată între 6 şi 8 săptămâni.
Rezultate: Evoluţia clinică a fost evaluată prin Glasgow Outcome Scale (GOS) la 6 luni de la externare. Cea mai frecventă cale de producere a abcesului cerebral a fost cea hematogenă. Studiul a cuprins 41 de pacienţi cu abcese unice şi 11 cu abcese multiple. Culturi pozitive din biopsia cerebrală au fost obţinute la 41 de pacienţi. Aspiraţia stereotactică a fost realizată la 33 de pacienţi, excizia chirurgicală la 15 iar 4 au fost trataţi doar medicamentos. În ceea ce priveşte evoluţia clinică, 84,6% din pacienţi au avut o evoluţie bună (GOS 5 şi 4) iar 15,4% una defavorabilă (dizabilităţi severe – 4 şi decese - 4).
Concluzii: Diagnosticul precoce, soluţia chirurgicală optimă şi utilizarea corectă a tratamentului antibiotic sunt esenţiale pentru un prognostic favorabil. Nu s-au înregistrat diferenţe semnificative, legate de prognostic, între cele două metode de tratament chirurgical. Factorii corelaţi cu o mortalitate crescută au fost un Glasgow Coma Score (GCS) < 8 la internare, prezenţa factorilor predispozanţi şi a unei infecţii sistemice.

Cuvinte cheie: abces cerebral, tratamentul abceselor cerebrale, prognosticul abceselor cerebrale

Abstract

Background: Brain abscesses are still a very important pathology, with high mortality and morbidity, even with the advancement of imaging technologies and antibiotic treatment. In this study, we analyzed the relationship between clinical, biological and therapeutic features at admission and clinical outcome in patients with brain abscesses.
Material and method: This is a retrospective study over 52 consecutive patients with brain abscesses treated in our Neurosurgical Department during 8 years, between January 2003 and December 2011. Laboratory tests, cerebral CT or MRI scans, blood and urine cultures were performed. Surgical treatment consisted of either CT guided stereotactic aspiration or craniotomy with the resection of the abscess. Materials from the brain abscess were cultured for aerobic and anaerobic

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bacteria. Parenteral antibiotic therapy usually lasted between 6 to 8 weeks.
Results: Clinical outcome was assessed at 6 months endpoint by using Glasgow Outcome Scale (GOS). The most common cause of brain abscess was hematogenous spread. There were 41 patients with solitary and 11 with multiple brain abscesses. Regarding microbiological findings, we obtained positive cultures from brain materials in 41 patients. Stereotactic aspiration was performed in 33 patients, surgical excision in 15 and medical therapy alone in 4 patients. As clinical outcome, 84.6% patients had a favorable outcome (GOS 5 and 4) and 15.4% had an unfavorable outcome (severe disability – 4 and death – 4).
Conclusions: Early diagnosis, optimal surgical intervention and timely use of appropriate antibiotics are essential for a good outcome. No significant difference in outcome was found among various surgical treatment modalities. For mortality, initial Glasgow Coma Score (GCS) < 8, associated predisposing factors and systemic infections were significant contributing factors.

Key words: cerebral abscess, cerebral abscess treatment, cerebral abscess outcome

Introduction

Although bacterial brain abscesses are a relatively uncommon disease, with an estimated incidence of 0.9 per 100000 person-years (1) in the developed countries, this malady might cause long-term neurological deficits or even death (2). As the neurological symptoms and systemic signs are relatively non-specific, the diagnosis and treatment of brain abscesses might be delayed (2).

Over the past two decades, advances in diagnosis and treatment modalities of brain abscesses have greatly improved the prognosis of this disease. Although, the widely used CT and MRI enhanced the radiographic diagnosis of brain abscesses, these imaging procedures still lack the specificity needed to establish a definitive diagnosis and determine the causative organism (1,3). Furthermore, imaging studies might be less sensitive in patients with immuno-suppressive conditions. Surgical procedures, such as imaging-assisted stereotactic techniques, have been used successfully in the diagnosis, as well as in the treatment of this disease. This minimally invasive technique is specifically used in the following situations: multiple abscesses, specific abscesses' locations, such as deep or eloquent areas, as well as in debilitated patients, using local anesthesia (4). Open surgical excision is indicated in some cases, but presents the disadvantage of creating an excess surgical trauma in an already edematous brain (4). Additionally, improved isolation techniques in the identification of micro-organisms have led to a more rational use of modern antibiotics. However, the conservative treatment alone might have good results only in selected cases and is commonly used as an adjuvant treatment to surgery. Combination of surgical and medical intervention has dramatically diminished long-term neurological deficits (5,6) as well as the mortality rates from 40%-60% in the pre-CT era (7-11) to 0-10% at present (5,11-14). Despite these advantages, the optimal management of brain abscesses remains however disputed. For example, the decision for surgical versus medical treatment, the decision for surgical excision versus aspiration taking into account the size, the number (multiple versus single), and the type (multiloculated versus uniloculated) of the abscesses, the decision of the type and duration of the antibiotic therapy, as well as the decision of the optimal use of corticosteroids, are all debated subjects (5,11,15,16).

The aim of the present study is to analyze the relationship between clinical, biological and therapeutic characteristics at the admission time and clinical outcome 6 months post-admission in 52 patients with bacterial brain abscesses. The results of this study will provide us with an insight into the evolution of the patient and will allow us to establish the optimal management of these problematic lesions.

Material and Method

Subjects

A retrospective review of medical records was undertaken for patients with brain abscess treated at the "Bagdasar-Arseni" Emergency Clinical Hospital, Bucharest for the period January 2003-December 2011. All patients were primarily cared by the Neurosurgical Clinic of the "Bagdasar-Arseni" Emergency Clinical Hospital. Fungal, parasitical and protozoan abscesses were not included. For each patient, symptoms and signs on admission and discharge, source of infection, risk factors for infection, basic parameters of the lesions, therapeutic attitude and parameters, as well as the clinical outcome were reviewed. Although the analysis was performed in a retrospective manner, the rationale and the therapeutic strategy were similar.

Clinical diagnosis and assessment

Cerebral CT scan and/or cerebral MRI were used for diagnosis and evaluation. The laboratory tests performed included peripheral white blood cell count (WBC) and erythrocyte sedimentation rate (ESR). Blood and urine culture were obtained to assess the possibility of a hematogenous source of infection. An ear, nose and throat (ENT) or a cardiologic consult was sometimes required to identify the primary source of infection. Lumbar puncture was avoided.

Treatment procedures

Surgical treatment was our first choice treatment for: (i) lesions with significant mass effect, (ii) lesions located in the proximity of the ventricle, (iii) an evidence of significant increased intracranial pressure, (iv) multiloculated abscesses. Surgical intervention consisted of either CT-guided stereotactic aspiration or craniotomy with resection of the abscess.

Generally, surgery was performed when the lesion was larger than 2.5 cm in diameter. Materials from bacterial abscesses were cultured for aerobic and anaerobic bacteria. Initial antibiotics of choice were changed if needed as sensitivities became available. We used parenteral antibiotic therapy for 6 to 8 weeks, followed by oral antibiotics until the resolution of abscesses. Corticosteroids were reserved only for patients with CT and clinical evidence of deterioration from marked mass effect. Anticonvulsants were used in most cases.

Medical treatment alone was considered in poor surgical candidates and in multiple and small abscesses.

The evolution of the lesions was radiologically evaluated by CT scan or MRI performed every two weeks or in the case of neurological deterioration. Further surgical intervention was considered whether: (i) an enlargement of the abscess was observed after two-week interval of treatment, (ii) no decrease in size after 4 weeks of antibiotics, and/or (iii) clinical deterioration. After a full course of antibiotics, cerebral CT was repeated every month for 6 months or until all abscesses resolved.

Statistical analysis

Primary clinical outcome was evaluated based on the Glasgow Outcome Scale (GOS) at 6 months post-admission. Clinical and neuro-radiological findings, treatment modalities and therapeutic results were summarized and statistical analyses were performed (chi square test).

Results

Clinical presentation

For our studies, 21 female and 31 male patients (female/male ratio=1/1.5) with average age 43.7 ±18.5 years (range 6-80 years) were selected.

At the time of admission, the most important neurological symptoms and signs were: (i) presence of a focal neurological deficit (i.e., hemiparesis, aphasia, visual defects), (ii) symptoms and signs of intracranial hypertension (i.e., headache, nausea, vomiting, papilledema); or (iii) mental status alteration. Focal neurological deficits were present in 22 patients (42.3%). On admission, 42 patients complained of headache (80.76%), and 18 had nausea and vomiting (34.61%). Papilledema was noted in 10 cases (19.23%). Seizures (generalized or partial) occurred in only 8 cases (15.38%).

27 patients had fever (51.92%) and signs of meningeal irritation were observed in 7 cases (13.46%) (*Table 1*). The classical triad of brain abscess (fever, headache and focal neurological deficits) was present in only 6 patients (11.53%). Mental status changes were graded from I to IV: I-patients had normal cognition and level of attentiveness; II-patients were stuporous but oriented and purposeful to direct questioning; III-patients were obtunded and exhibited purposeful behavior to painful stimuli only; IV-patients were comatose. 26 patients had mental status I (50%), 20 patients with II (38.46%) and 4 with III (7.69%). Two patients were mental status IV (3.84%).

Table 1. *Symptoms and signs*

Symptoms and signs	No. of patients	%
Headache	42	80.76%
Nausea and vomiting	18	34.61%
Papilloedema	10	19.23%
Altered state of consciousness	6	11.53%
Focal neurological deficits	22	42.30%
Seizures	8	15.38%
Fever	27	51.92%
Signs of meningeal irritation	7	13.46%

Mean duration of symptoms before diagnosis was 25 days (range 3-60 days).

Source of brain abscess and predisposing factors

The primary source of infection was identified in 31 patients (59.61%). The most common cause of brain abscess in our population was hematogenous spread (14 cases – 26.92%): 5 patients with cyanotic heart diseases, 2 patients with bacterial endocarditis, 3 patients with lung abscess, and 2 patients with dental abscess (*Fig. 1*). Contiguous spread was identified in 12 cases (23.07%): 8 patients with middle-ear and mastoid air sinus infections, and 4 patients with paranasal sinusitis (*Fig. 2*). Three brain abscesses due to a post-surgery nosocomial bacterial infection were noted (5.76%). In 3 patients, brain abscesses were observed following penetrating cranial trauma (5.76%) (*Table 2*).

Predisposing factors for developing opportunistic or atypical infection were noted in 9 cases (17.30%): 5 immunocompromised patients, one diagnosed with AIDS and 3 with hematologic disease. Five patients (9.61%) had cardiac morbid conditions. As underlying diseases, diabetes mellitus was identified in 6 cases (11.53%) and cirrhosis in 4 cases (7.69%).

Characteristics of the abscesses

All patients had cerebral CT scans, while cerebral MRI was only performed in 34 (65.38%) cases.

There were 41 solitary (78.84%) and 11 multiple (21.15%)

Table 2. *Source of brain abscess*

Source of brain abscess	No. of patients	%
Contiguous spread	12	23.07%
- middle-ear and mastoid air sinus infection	8	23.07%
- paranasal sinusitis	4	23.07%
Hematogenous spread	14	26.92%
- cyanotic heart disease	5	26.92%
- bacterial endocarditis	4	26.92%
- lung abscess	3	26.92%
- dental abscess	2	26.92%
Post neurosurgical procedure	3	5.76%
Following penetrating cranial trauma	3	5.76%
Unknown	20	38.46%

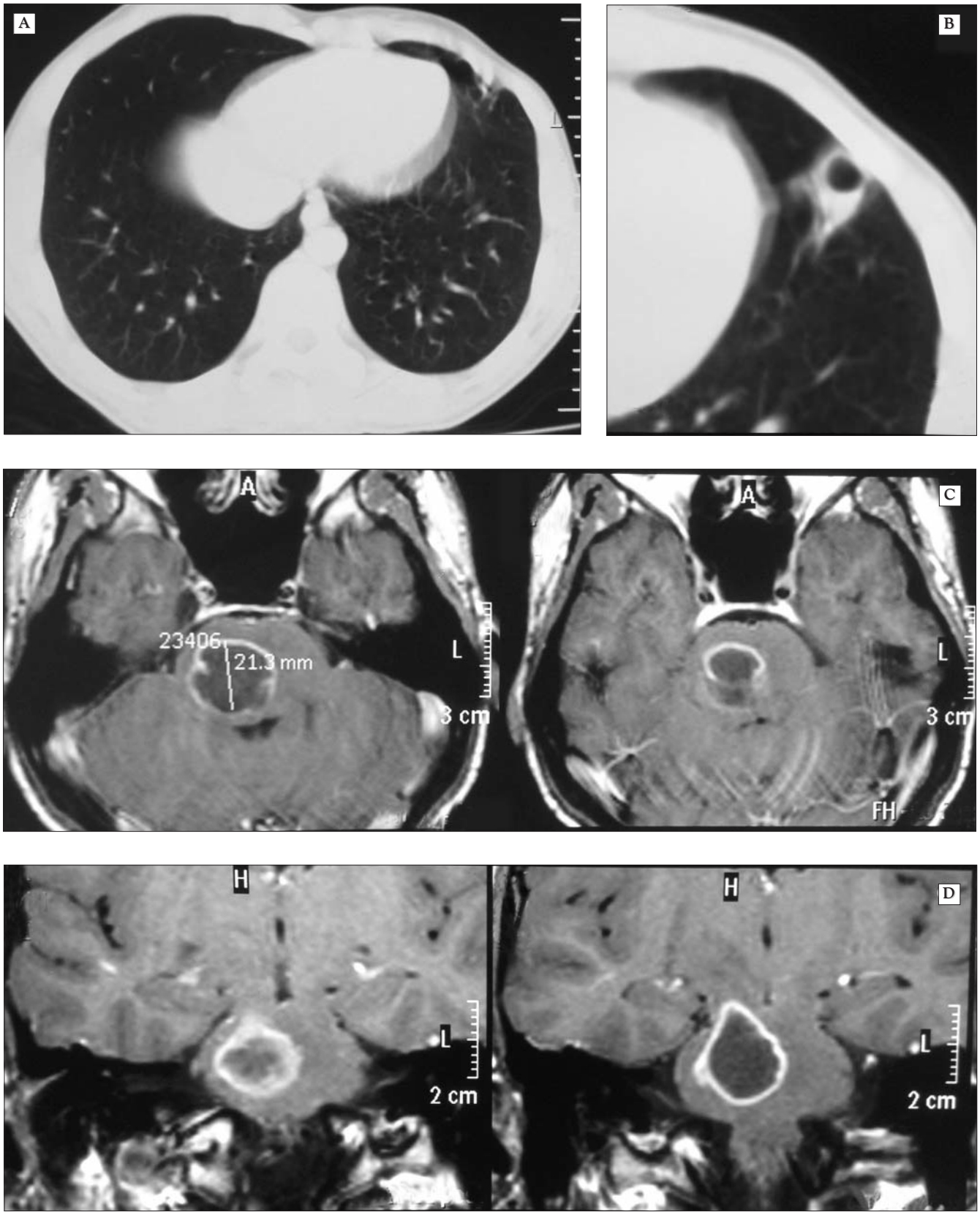

Figure 1. *Male, 56 years old, known with a lung abscess, operated on by stereotactic aspiration for a deep-sited brain stem abscess. Brain abscess cultures were positive for Klebsiella Pneumoniae. (**A,B**) parietal left inferior pulmonary lobe abscess; (**C,D**) preoperative axial and coronal gadolinium enhanced MRI images;*

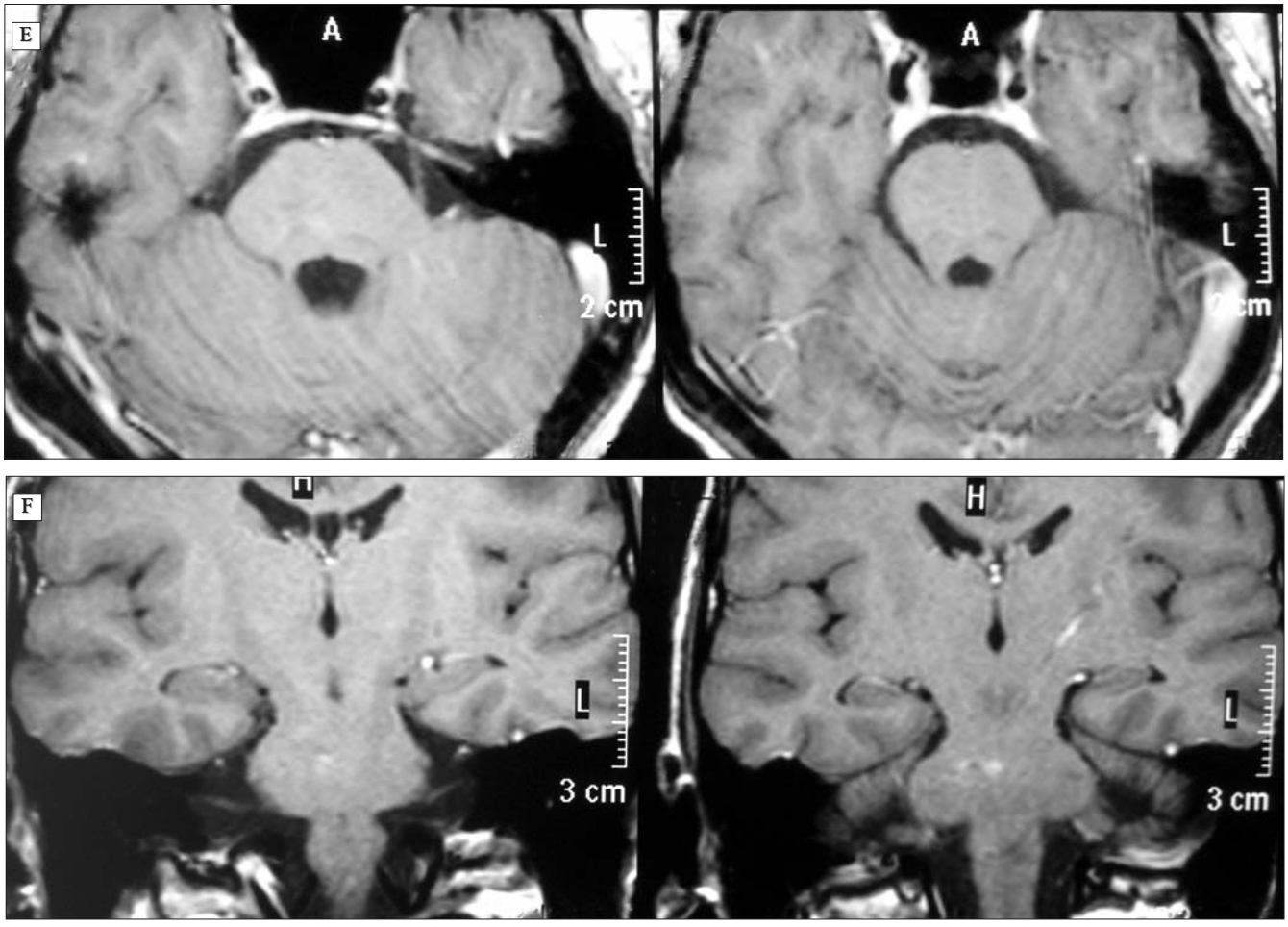

Figure 1. *Male, 56 years old, known with a lung abscess, operated on by stereotactic aspiration for a deep-sited brain stem abscess. (**E,F**) 6 months postoperative axial and coronal gadolinium enhanced MRI images, showing the complete resolution of the brain stem abscess*

Figure 2. *Female, 16 years old, with no significant medical history, surgically treated through an open craniotomy for a left fronto-basal brain abscess. Brain abscess cultures were positive for Staphylococcus Aureus. (**A,B**) important left paranasal sinusitis involving the left frontal and ethmoidal sinuses*

abscesses. In cases with multiple abscesses, the number of lesions varied between 2 and 5. The most common location for solitary abscesses was the frontal lobe (10 cases-24.39%), followed by the temporal (9 cases-21.99%), parietal (7 cases-17.08%), and occipital (3 cases-7.31%) lobes. There were 5 abscesses in the basal ganglia and thalamus (12.19%) and 7 in the cerebellum (17.08%). Sinogenic abscesses were located in the frontal lobe, whereas otogenic abscesses were located mainly in the temporal lobe and cerebellum (*Table 3*). Multiple abscesses were located in more lobes: 9 out of 11 had a hematogenous spread of infection. The statistical data showed a significant correlation between these conditions (OR=42.00, p=0.003).

There was one intraventricular rupture of brain abscess in our series.

Microbiological findings

The microbiological studies included culture of the brain abscess material in 48 cases (92.30%). Whenever possible,

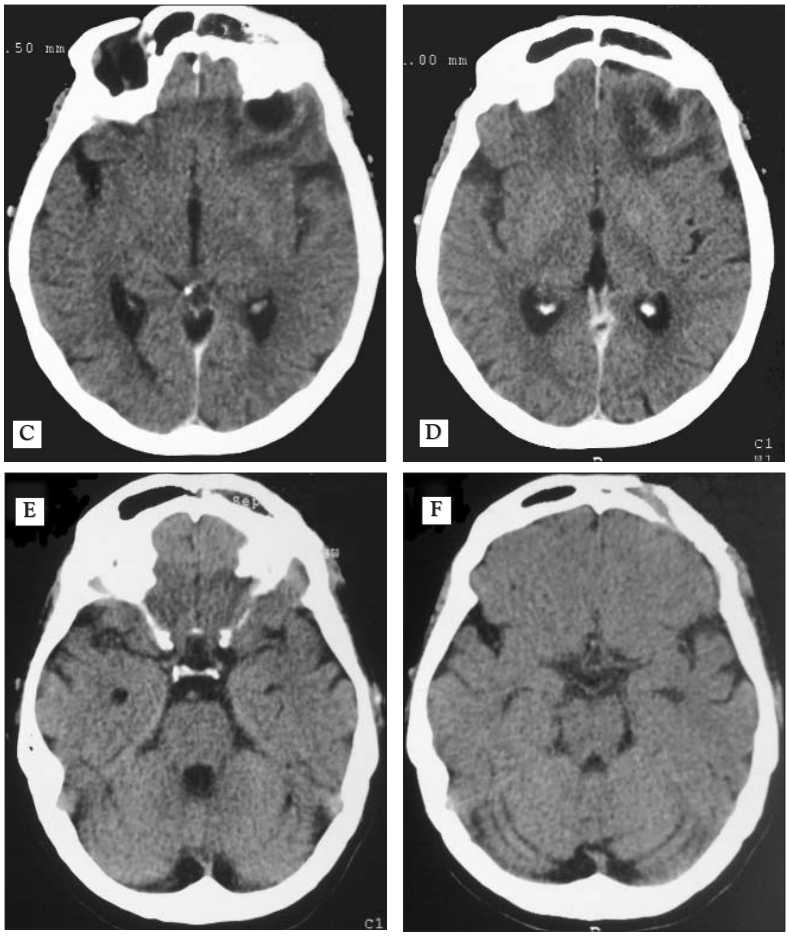

Figure 2. *Female, 16 years old, with no significant medical history, surgically treated through an open craniotomy for a left fronto-basal brain abscess. Brain abscess cultures were positive for Staphylococcus Aureus. (**C,D**) preoperative contrast CT scan; (**E,F**) postoperative contrast CT scan showing the complete resolution of the abscess (after 3 months)*

antibiotic therapy was delayed until at least one abscess was aspirated. Cultures were sterile in 7 out of 48 surgical patients (negative rate=14.58%). However, in 5 out of 7 cases with negative cultures, antibiotics were used before surgical aspiration.

In the 41 culture-positive patients, a single pathogen was identified in 35 cases (85.36%) and multiple pathogens were isolated in 6 cases (14.63%). The most frequently encountered microorganisms were Gram-positive cocci (Staphylococcus and Streptococcus) and Enterobacteriaceae (Klebsiella pneumoniae, Proteus mirabilis, and Escherichia coli) - *Table 4*.

Laboratory findings

Laboratory tests used to evaluate the patient included peripheral white blood count (WBC) and erythrocyte sedimentation rate (ESR), although these are not specific and could be elevated in many disorders. Peripheral WBC was within normal range in 10 cases (19.23%), elevated in 39 cases (75.00%) and depressed in 3 cases (5.76%). ESR was within normal range in 5 patients (9.61%) and elevated in 47 patients (90.38%).

Blood and urine cultures were obtained in selected cases, to assess the possibility of a hematogenous source of infection. Blood cultures were performed in 20 patients with a clinical presentation of systemic infection, but they were positive in only 10 cases (positive rate=50%). The same microorganism

Table 3. *Location of the solitary abscesses*

Location of the abscess	No. of patients	%
Frontal lobe	10	24.39%
Temporal lobe	9	21.95%
Parietal lobe	7	17.08%
Occipital lobe	3	7.31%
Basal ganglia and thalamus	5	12.19%
Cerebellum	7	17.08%

Table 4. *Microorganisms isolated from brain abscess*

Type of microorganisms	No of cases
Gram-positive cocci	25
- staphylococcus aureus	17
- coagulase-negative staphylococci	2
- viridans group streptococci	6
Enterobacteriaceae	12
- klebsiella pneumoniae	5
- proteus mirabilis	4
- escherichia colli	3
Pseudomonas aeruginosa	2
Anaerobes (peptostreptococcus, bacteroides)	2
Negative culture	7
Laboratory findings	

was isolated in both blood and brain cultures in 4 cases. Two patients underwent lumbar puncture, but their cerebrospinal fluid (CSF) culture was sterile.

Treatment

All patients were treated with multiple antibiotics, typically in combination rather than a single drug. Whenever possible, the selection of antibiotics was made based on the available culture sensitivity data. Medical therapy alone was performed in 4 patients (7.69%): 3 with multiple small abscesses and one with a single abscess smaller than 2.5 cm in diameter. In these cases, the duration of antibiotic therapy ranged from 8 week to 23 weeks.

Corticosteroid therapy was used only in selected cases, to reduce brain edema and mass effect, which contribute to the neurological deterioration of the patient. Anticonvulsants were used as long-term therapy in most cases (45 cases – 86.53%).

48 patients underwent one or more surgical procedures (92.30%). Stereotactic aspiration under CT guidance was performed in 33 cases (68.75%) and surgical excision in 15 cases (31.25%).

Stereotactic aspiration was preferred over open craniotomy as a first-choice surgical therapy (*Fig. 3*). Thus, stereotactically accessible abscesses larger than 2.5cm in diameter or abscesses causing significant mass effect were aspirated. Lavage of the abscess cavity using normal saline solution and broad-spectrum antibiotics was performed in all cases. In 7 patients with multiple abscesses (11 in total), more than one abscess were aspired during initial surgery. Repeated stereotactic drainage was required in 6 cases (18.18%). The decision to evacuate again was based on the finding of an increased size of the abscess after 1-2 weeks of antibiotics or due to clinical deterioration.

Indications for open surgery included multiloculated abscesses (5 cases), traumatic abscesses associated with foreign material (3 cases) and abscesses located in the posterior fossa (7 cases).

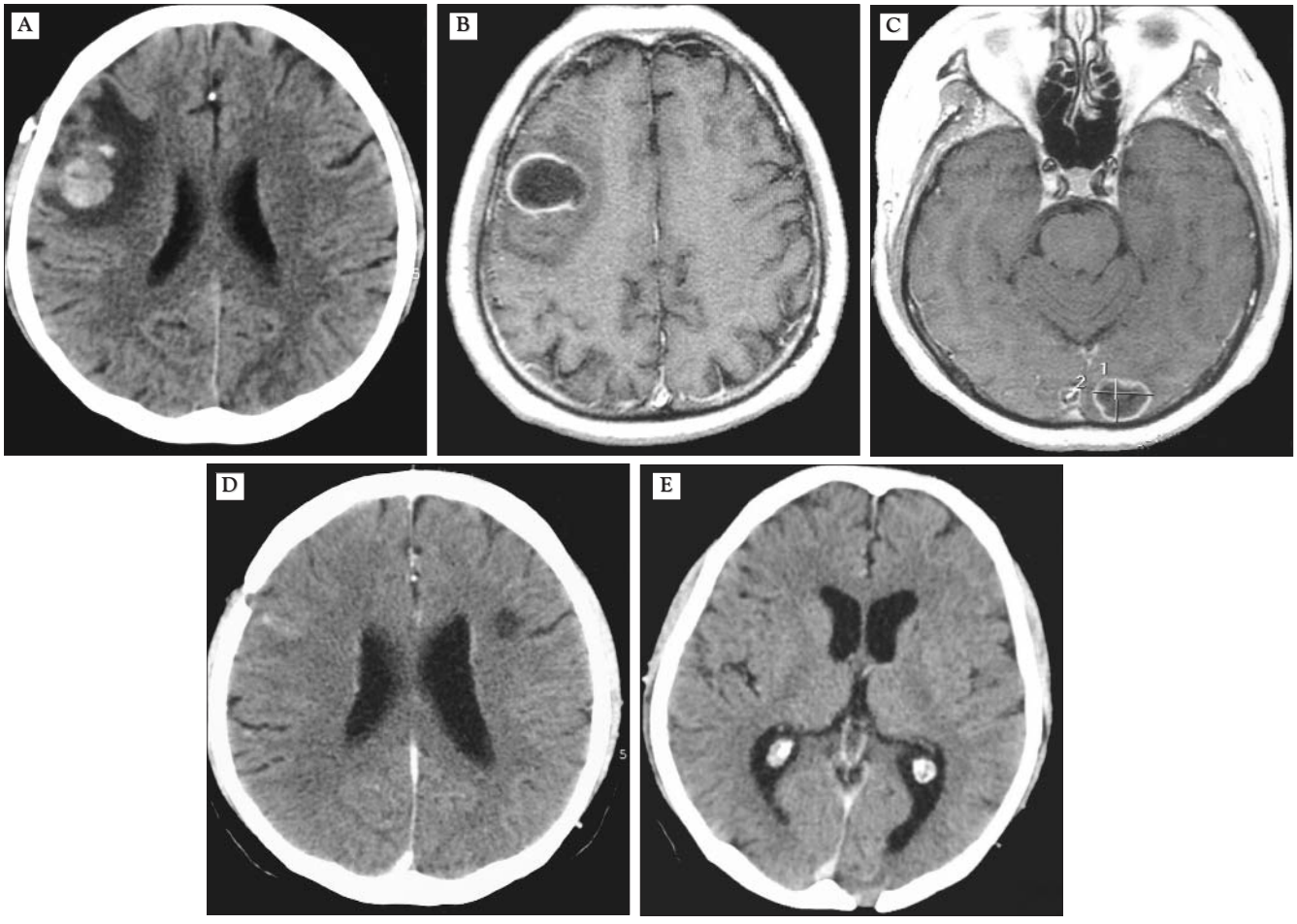

Figure 3. *Male, 43 years old, with a six-year history of diabetes mellitus, surgically treated by stereotactic aspiration procedures for two brain abscesses localized in the right frontal lobe and in the left occipital lobe. Brain abscess cultures were positive for Streptococcus Viridans. (**A**) preoperative contrast CT scan; (**B,C**) preoperative axial gadolinium enhanced MRI, showing the presence of the brain abscesses; (**D**) 8 months and (**E**) 12 months postoperative contrast CT scans, showing the complete resolution of the abscesses*

Outcome

The clinical outcome was assessed at 6-months endpoint by using the Glasgow Outcome Scale (GOS). It has to be noted that at that time point, all patients had no abscesses identified by neuro-imaging assessment.

Favorable outcome was defined as good recovery or moderate disability (disabled but independent). Unfavorable outcome was defined as severe disability (disabled and dependent for daily support), persistent vegetative state or death. A total of 44 patients (84.61%) had a favorable outcome: 20 (38.46%) with good recovery (no sequelae) and 24 (46.15%) with moderate disability (presence of neurological deficits with preserved ability to perform daily living activities; or presence of seizures, satisfactory controlled by medical therapy). Eight patients (15.39%) had unfavorable outcome: 4 (7.70%) had a severe disability (presence of neurological deficit with total dependence in daily living activities; or presence of drug-uncontrolled seizures) and 4 others (7.70%) deceased due to neurological causes (2 patients), pulmonary insufficiency (1 patient) and cardiac reasons (1 patient) (*Table 5*).

The recurrence rate was 11.53% (6 cases), and a combined antibiotherapy and stereotactic aspiration was performed.

Clinical follow-up ranged from 6 to 53 months (average 16.57 months).

The analysis for factors and their relationships with outcome was performed. Univariate analysis revealed that patients with unfavorable outcome had an initial Glasgow Coma Score (GCS) < 8 (chi square test $p < 0.08$), seizures (chi square test $p < 0.07$) and underlying diseases (cyanotic congenital heart disease or cirrhosis). No association was found between outcome and other factors including age, focal neurological deficits, fever, laboratory findings, and treatment modalities.

For mortality, initial Glasgow Coma Score (GCS) < 8, associated predisposing factors and underlying diseases or systemic infections were significant contributing factors. No significant difference in the outcome was found among various treatment modalities.

Discussion

Although brain abscesses are uncommon, they still keep their importance with high mortality and morbidity, even with the advancement of imaging technologies and antibiotic treatment (12,17,18). The mortality is still relatively high. It is counted around 10% in series reported before 2000 (11,13,14) and was between 17% and 32% in several series reported after 2000 (19-22). This discrepancy may be mainly due to the drastic changes in epidemiology taking place nowadays when the incidence of brain abscesses caused by otic/sinus infection has decreased, whereas those associated with immunodeficiency increased markedly. However, 4 patients (7.70%) in the present study were associated with immune deficiency or hematologic disease, and two of them died.

Table 5. *Glasgow Outcome Scale (GOS)*

Score	Meaning	No. of patients	%
5	Good recovery	20	38.46%
4	Moderate disability	24	46.15%
3	Severe disability	4	7.70%
2	Persistent vegetative state	0	0
1	Death	4	7.70%

In our study, the 7.70% mortality rate was lower than in most reported series (2,11,13,14). One possible explanation is that we did not have many critically ill patients included in our series. Patients with a Glasgow Coma Scale (GCS) lower than 8 at admission represented only 11.53% (6 patients) of our series. All patients who died had predisposing factors or underlying diseases. Most studies, including ours, did not evaluate the severity of underlying disease in patients with brain abscesses; therefore, it is difficult to compare the results among various series.

The most common predisposing factor for brain abscesses are direct spread from middle ear, mastoid or paranasal sinuses (23-25). It is worth to be note that, in the last two decades, the trend of epidemiology of brain abscesses had switched, most published series showing a decreasing incidence of otogenous abscess and an increasing incidence in hematogenous spread and among patients with a compromised immunity (12,26).

In our series, cultures of brain abscess materials grow gram-positive cocci (most frequent encountered being staphylococcus aureus) and gram negative bacilli (Klebsiella, Proteus mirabilis and Escherichia colli). Only half of the patients with clinical signs of systemic infection had positive blood cultures (10 out of 20 patients). Despite this 50% positive rate, in 4 cases we found the same pathogen as in the blood culture in the abscess material.

In patients with a right-to-left shunt, decreased arterial oxygen saturation combined with increased blood viscosity owing to increased hemoglobin levels, may cause focal brain ischemia, which could serve as an excellent nidi for infection (27). Furthermore, the right-to-left shunt can bypass the filter effect of pulmonary circulation; therefore, early correction of this shunt may reduce the likelihood of developing brain abscesses in these patients, instead of carrying out palliative procedures alone (27).

The most frequent symptoms in our series were headache, nausea, vomiting, fever, focal neurological deficits and papilledema. Clinical symptoms and signs are not specific for brain abscesses depending on their size and location, the underlying systemic conditions and the virulence of infecting organisms (12,18,28). Short duration of symptoms from the onset to admission correlated with a poor outcome (12,17,18). In our series, mean duration of symptoms before diagnosis was 25 ± 25 SD days (range 3-60 days). No correlation was noted, in this study, between the location of the abscess and the duration of symptoms.

Lumbar puncture should not be done for the risk of brain herniation (17,24,26,28). In the literature, only 10% to 30% positive CSF cultures compatible with abscess cultures were reported (5,23,26). We performed lumbar puncture only when a strong suspicion of concomitant meningitis and no signs of

increased intracranial pressure were present. Lumbar puncture was performed in two of our patients, and their CSF examination was sterile.

The incidence of multiple abscesses was reported to be 10-50% in different series, and as high as 61%, especially in the series of infants (5,12,29). In the present study, it was 21.15% (meaning 11 out of 52 patients). In early series, the mortality rate in patients with multiple cerebral abscesses was higher than solitary abscesses (5,12). The reasons for a high mortality of these patients were delay in diagnosis and lack of an aggressive antibiotic therapy. In this study, as in the last published series (14,17,24), the prognosis of multiple abscesses were similar to solitary ones.

Culture of abscess material provided during surgery is the best opportunity to make a microbiological diagnosis, although the incidence of sterile culture is high for patients already receiving antimicrobial therapy (17,30). For critically ill patients an initial broad-spectrum antibiotic coverage for the most common organisms should be provided before the culture results became available. This initial antimicrobial therapy could be chosen according to the most likely infecting pathogens at the suspected site of entry (17).

The most commonly isolated micro-organisms in our series were staphylococcus species, followed by streptococcus, Klebsiella pneumoniae and proteus mirabillis. The difference, regarding the micro-organisms isolated in this series, comparing to other series (2,31-33) is the higher incidence of staphylococcus species over the streptococcus or gram-negative organisms. In recent years, anaerobic micro-organisms are being frequently isolated from brain abscesses (34,35). We noted only two cases in which anaerobic bacteria (bacteroides and, respectively peptostreptococcus) were isolated. In 7 out of 48 patients no organisms were isolated, most of these patient having received broad-spectrum antibiotic therapy before obtaining culture material. The most important factor responsible for sterile cultures was the usage of antibiotics before surgical intervention (32,33).

Since CT scanning has been used for diagnosis, some studies advocated nonsurgical treatment for patients who are poor candidates for surgery or for those with surgically inaccessible lesions (12,36). Dyste and Rosenblum (9) considered that medical treatment should be applied on cortex localized brain abscess when their diameters are 10-17 mm. Mampalam (5) suggested that medical treatment was feasible for deep-sited abscesses with a diameter around 20 mm, and for those bigger than 30 mm diameter surgical treatment was advised.

The major drawback of the nonsurgical treatment is its potential toxicity in prolonged administration of antimicrobial therapy (37). Therefore, except during the stage of cerebritis, surgical treatment should be attempted, which not only achieves a reduction of the mass effect, but also obtains abscess material for identifying infecting pathogens and, thus, facilitates the selection of antibiotics (38).

Mamelak and co-workers (5) recommended the following management policy: (1) all abscesses larger than 2,5 cm in diameter or that are causing significant mass effect should be excised or stereotactically aspired; if abscesses are smaller than 2,5 cm in size or are not causing mass effect, the largest most accessible one should be aspired for diagnostic purpose and selection of antibiotics (2) once the culture has been obtained, broad-spectrum antibiotics should be immediately started and continued for a minimum 6 weeks (usually 8 weeks) and, in immune compromised patients, often for 1 year or longer (3) postoperatively, CT or MRI should be performed biweekly for monitoring evidence of abscess re-expansion or failure to resolve despite antibiotics. In cases caused by more resistant pathogens, such as fungi or Nocardia species, complete excision is more favorable than simple drainage (12).

Because stereotactic techniques are effective with minimal risk, they were the most frequently used in our patients (33 out of 48 patients who underwent surgical procedures). Stereotactic aspiration was performed using the Cosman-Roberts-Wells stereotactic system, targeting the lesion. This technique reduced immediately the mass effect of the abscess, and provided not only the confirmation of diagnosis, but avoided occasional antibiotic therapy of some other lesions that can resemble brain abscesses (33). Stereotactic aspiration combined with antibiotic therapy can be applied even in lesions located in the brain stem or other areas, among patients with high risk for surgery or multiple brain abscesses (39).

In our series, open surgery was preferred for the abscesses located in the cerebellum (more than half of the cases in this cohort) and lesions which produced important mass effect. We avoided open surgery in abscesses located in eloquent areas and for those in cerebritis stage.

As antibiotic combination, the most used was metronidazole with a third generation cephalosporin. Metronidazole was preferred because of its bactericidal activity against strict anaerobes, reaching high concentration in pus. Over the last years, more powerful antibiotics started to play an important role in our medical treatment of cerebral abscess or meningitis, as: meropenem (a beta-lactam belonging to the group of carbapenem), vancomycin (treatment of penicillin-resistant staphylococcus aureus), ticarcillin (a beta-lactam used for the treatment of gram-negative bacteria, particularly pseudomonas aeruginosa). In our study, the duration of parenteral antibiotic treatment was between 4 and 8 weeks. Corticoids were used for patients with significant edema and associated mass effect causing increased intracranial pressure. Once the edema or mass effect had been alleviated, corticosteroids were tapered as rapidly as possible, to avoid the retardation of immune responses and abscess wall formation (2,5,33).

The most important factor on prognostic and mortality in patients with brain abscess is the admission Glasgow Coma Score (GCS) (the initial neurological status). The mortality is higher in patients whose symptoms are shorter, mental alterations are serious and neurological dysfunction is rapid (12,17,26). Most studies published in the last decade still document high mortality and morbidity in patients with brain abscess. In the Bidzinski and Koszweski's report in 2002: 63% had good recovery, 23% developed moderate disability, 9% had severe disability and 5% of patients died

(40). Over a large series of 178 patients with brain abscesses, Xiao et al (2) found the following results: 62% with favorable outcome, 8% had severe disability, 5% became vegetative and 25% died during hospitalization. A series of 96 patients with brain abscesses, published by Hakan et al (2005) (32) had a low overall mortality rate of 8.33%. In our series of 52 consecutive patients, 4 patients (7.70%) died during hospitalization. There were 4 patients (7.70%) who remain totally dependent in activities of daily living. The other 44 patients (84.61%) had a more favorable outcome: 38.46% - with good recovery (GOS – 5), and 46.15% with moderate disability (GOS – 4).

In our study the recurrence rate was 11.53% (6 cases). Recurrence rate in many other studies was between 7% and 18%. Prompt and suitable treatment of initial infection is the most preventive factor of recurrence (41).

Conclusions

Early diagnosis, optimal surgical intervention and timely use of appropriate antibiotics based on antimicrobial susceptibility testing are essential for a good outcome. Although brain abscesses can be successfully treated with antibiotics alone, in appropriate cases, surgery still holds the main role in the treatment management. Aspiration-type operation is the mainly preferred surgical method that first preferred and must be performed for diagnosis and therapy in most patients with brain abscess.

Parenteral antibiotics should be given for six to eight weeks, depending on the type of operation. Postoperatively, serial CT or MRI scan should be obtained biweekly during treatment and then monthly for 3 to 5 months or until contrast enhanced CT or MRI scans show that the abscess has disappeared.

No difference in outcome is found among various treatment strategies and choices of surgical procedure. It depends on prompt awareness of the diagnosis and effective infection control.

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