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BRAIN ABSCESS IN A RESOURCE-LIMITED SETTING:

Clinical Profile, Management Strategies, and Outcomes from a Single-Center Experience in Algeria

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ABSTRACT

Background: Brain abscess is a life-threatening intracranial infection that remains a major challenge in developing countries despite advances in neuroimaging and antimicrobial therapy.

Objective: To analyze the clinical, radiological, microbiological, and therapeutic characteristics of brain abscess and identify prognostic factors influencing outcomes.

Methods: A retrospective study was conducted between 2019 and 2022 at the Neurosurgery Department of Frantz Fanon Hospital, Blida, Algeria. Patients with confirmed brain abscess were included. Clinical presentation, imaging findings, microbiological data, treatment modalities, and outcomes were analyzed.

Results: Eleven patients were included (mean age: 28 ± 14.3 years; male predominance). Neurological deficit (80.5%) and intracranial hypertension (54.5%) were the most frequent symptoms. ENT infections were the main portal of entry. CT scan confirmed diagnosis in 87.8% of cases. The most common pathogens were anaerobes and *Proteus mirabilis*. Surgical drainage via trepanation was performed in 75% of patients. Morbidity was 40.6%, while mortality remained low (~1%).

Conclusion: Brain abscess remains a severe condition in resource-limited settings. Early diagnosis and combined medical-surgical management are essential to improve outcomes.

Keywords: *Brain abscess; intracranial infection; neurosurgery; prognosis; developing countries*

INTRODUCTION

Brain abscess is a focal intracerebral infection characterized by a localized collection of pus within a vascularized capsule. It represents a neurosurgical emergency due to the risk of rapid progression and severe complications such as intracranial hypertension and cerebral herniation.

Although its incidence has declined in developed countries, brain abscess remains a significant health problem in developing regions, largely due to delayed diagnosis and untreated infections such as otitis and sinusitis [1,2]. The clinical presentation is often nonspecific, and the classical Bergman triad is inconsistently observed, contributing to diagnostic delays [3].

Neuroimaging plays a central role in diagnosis. Computed tomography (CT) remains the first-line modality, while magnetic resonance imaging (MRI) offers superior sensitivity in differentiating abscess from other intracranial lesions [4]. Management relies on a combination of antimicrobial therapy and surgical intervention adapted to clinical and radiological findings [5].

Despite advances in treatment, morbidity and mortality remain significant. Prognosis depends mainly on neurological status at admission and early initiation of treatment [3,6].

This study aims to evaluate the clinical, radiological, microbiological, and therapeutic characteristics of brain abscess in our institution and to identify prognostic factors influencing outcomes.

MATERIAL & METHODS

This retrospective study was conducted in the Department of Neurosurgery, Frantz Fanon University Hospital Center (Blida, Algeria), between 2019 and 2022.

All patients diagnosed with brain abscess based on imaging and/or microbiological findings were included. Data collected included demographic characteristics, clinical presentation, imaging findings, microbiological results, treatment modalities, and outcomes.

All patients underwent clinical examination and contrast-enhanced CT scan at admission. MRI was performed in selected cases. Treatment strategies included medical therapy alone or combined with surgical intervention (trepanation or craniotomy).

Follow-up consisted of clinical assessment, repeated CT scans, and inflammatory markers. Outcomes were evaluated in the short term (≤1 month), medium term (1 year), and long term (>1 year).

RESULTS

Demographic Data

A total of 11 patients were included in this study. The mean age was 28 ± 14.34 years, with a clear male predominance (sex ratio: 1.5). This distribution reflects the tendency of brain abscess to affect young adults.

Clinical Presentation

The clinical presentation of brain abscess in our series was dominated by focal neurological deficits, observed in 80.5% of patients, making it the most frequent manifestation. Signs of intracranial hypertension were present in 54.5% of cases, while fever was reported in 37.2%, reflecting the variability and often nonspecific nature of clinical symptoms. Seizures occurred in 18.2% of patients, and disturbances of consciousness were noted in 27.3%. Compared with data from the literature, our findings show a relatively higher frequency of neurological deficits, which may suggest delayed diagnosis or more advanced disease at presentation. Conversely, the frequency of fever in our series appears lower than that reported in several studies, highlighting the inconsistency of infectious signs in brain abscess. Overall, these variations underline the heterogeneity of clinical presentation and the importance of maintaining a high index of suspicion. **(Table I).**

Table I. Clinical Presentation Compared with Literature

Study	Intracranial Hypertension (%)	Fever (%)	Seizures (%)	Consciousness Disorders (%)	Neurological Deficit (%)
Xiao et al. [3]	15	63	16	23	45

Study	Intracranial Hypertension (%)	Fever (%)	Seizures (%)	Consciousness Disorders (%)	Neurological Deficit (%)
Menon et al. [5]	78	83	17	29	2
Tseng et al. [6]	51.4	—	13	25.4	57.7
Hakan et al. [7]	54	57	25	44	42
Chaoui et al. [8]	83.3	54.2	29.2	47.7	65.3
Our series	**54.5**	**37.2**	**18.2**	**27.3**	**80.5**

Bergman Triad

The classical Bergman triad, defined by the association of fever, headache (intracranial hypertension), and focal neurological deficit, was complete in only 17% of patients (n = 2) in our series. This finding is consistent with the literature, where the full triad is reported in a minority of cases, reflecting the often atypical and variable clinical presentation of brain abscess. The low frequency of the complete triad highlights the diagnostic challenge and emphasizes the importance of considering brain abscess even in the absence of the full classical presentation **(Table II).**

Table II. Frequency of Complete Bergman Triad

Parameter	Number	Percentage
Complete triad	2	17%

Diagnostic Delay

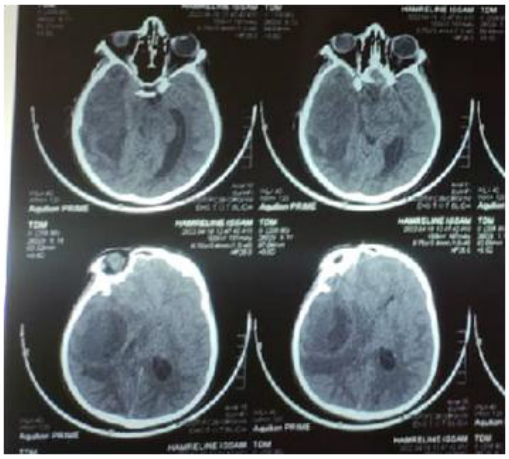
The diagnostic delay ranged from 15 days to 3 months, with a mean duration of 24 days. This delay reflects the nonspecific clinical presentation and possible limitations in access to specialized care. Such delays may contribute to disease progression and increased complication rates.

Portal of Entry

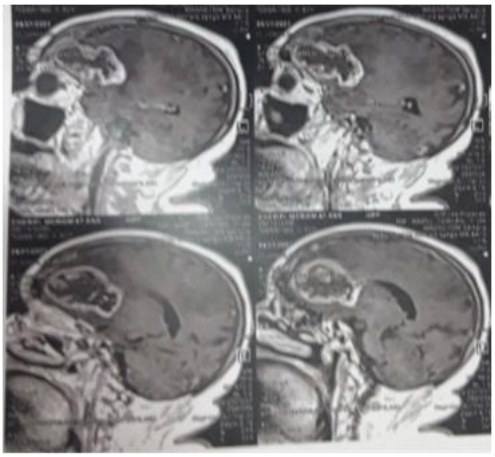
The portal of entry was identified as ENT infections in 27% of cases, while it remained unknown in 9% of patients. ENT infections represent a major source due to anatomical proximity and potential for contiguous spread.

Radiological Findings

Contrast-enhanced CT scan showed a typical ring-enhancing lesion in 87.8% of cases. The most frequent location was temporal (36.36%). The mean abscess size was approximately 50 mm..Magnetic resonance imaging in diffusion and metabolic sequences (spectroscopy) is used in two cases with high sensitivity and specificity.



A: Axial Brain CT Scan



B:Sagittal Brain MRI

Figure 1. Neuroimaging Features of Brain Abscess

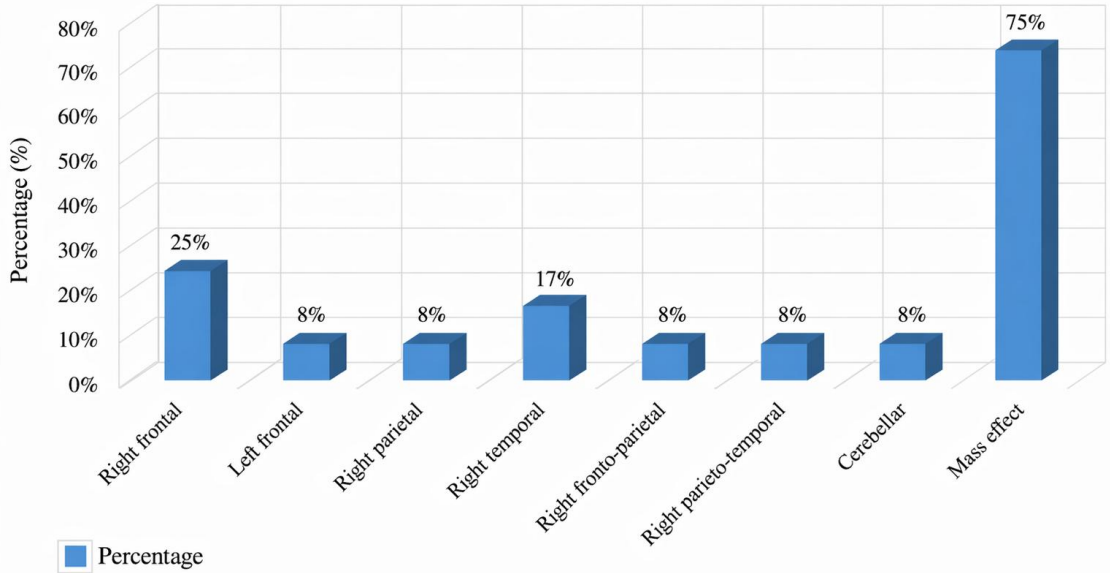
Figure 1A (CT Scan):

The axial contrast-enhanced computed tomography (CT) images demonstrate a well-defined hypodense lesion with a characteristic ring-shaped peripheral enhancement. This appearance reflects the presence of a capsule surrounding a central necrotic core, which is typical of a brain abscess. The

lesion is associated with significant perilesional edema, visible as hypodensity in the surrounding brain tissue. In addition, a notable mass effect is observed, resulting in compression of adjacent cerebral structures and possible midline shift. These findings are highly suggestive of an intracranial abscess at an advanced stage.

Figure 1B (MRI):
The sagittal magnetic resonance imaging (MRI) sequences reveal a well-circumscribed lesion with a thick, enhancing capsule and a central area of necrosis. The surrounding vasogenic edema is more clearly delineated compared to CT imaging, highlighting the superior sensitivity of MRI in evaluating soft tissue changes. The lesion exerts a mass effect on adjacent brain structures, confirming its clinical significance. MRI provides better anatomical resolution and is particularly useful for differentiating brain abscess from other intracranial lesions such as tumors or cystic processes, especially when combined with advanced sequences like diffusion-weighted imaging.

Figure 2. Distribution of Brain Abscesses According to Location (Percentages)



Percentages may exceed 100% due to multiple locations in some patients.

Biological Findings

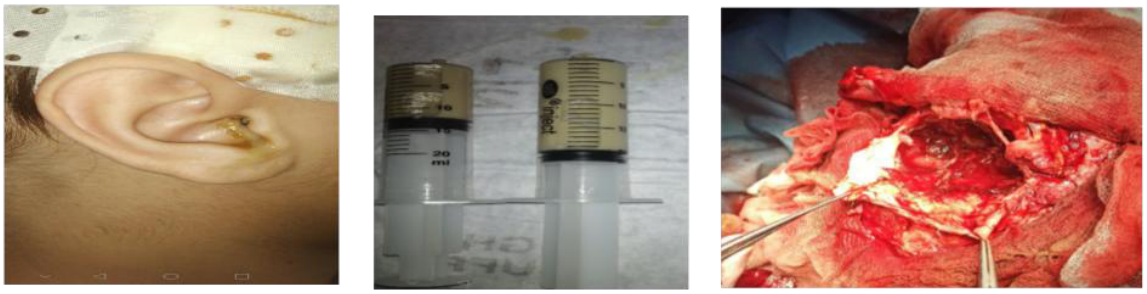
Biological analysis revealed elevated inflammatory markers (CRP and ESR) in 63% of patients, supporting the infectious nature of the condition.

Microbiology

Microbiological findings showed a predominance of anaerobic bacteria and *Proteus mirabilis* (17% each). Other organisms included *Salmonella*, *Veillonella parvula*, *Streptococcus*, and *Pneumococcus* (8% each), confirming the polymicrobial nature of brain abscess.

Etiology / Management:

Brain abscesses in our series were mainly related to ENT infections, particularly otogenic sources. Management combined antibiotic therapy with surgical intervention, including aspiration for both decompression and microbiological diagnosis, and surgical drainage in selected cases depending on abscess characteristics. These findings are illustrated in Figure 3.



A B C

Figure 3. Clinical and Surgical Aspects of Brain Abscess Management

(A) Otogenic infection with purulent discharge, representing a possible portal of entry.
(B) Purulent material obtained after abscess aspiration.
(C) Intraoperative view showing surgical drainage of the brain abscess.

Treatment Modalities

The management of brain abscess in our series relied primarily on a combined medical and surgical approach. Surgical intervention was indicated in the majority of patients, depending on the size, location, and clinical presentation of the abscess. Trepanation with aspiration was the most frequently performed procedure, accounting for 75% of cases (n = 9). This technique was preferred due to its simplicity, effectiveness, and lower invasiveness, allowing adequate drainage of the purulent collection while minimizing surgical risk.

In 25% of patients (n = 3), aspiration was followed by craniotomy, either due to insufficient clinical improvement or unfavorable abscess characteristics such as large size or multiloculated lesions. No cases of stereotactic aspiration were performed in our series, likely reflecting limited availability of this technique in our setting **(Table IV).**. Overall, treatment strategies were adapted to individual patient conditions, emphasizing the importance of prompt surgical management combined with appropriate antibiotic therapy.

Table IV. Treatment Modalities

Method	**Number**	**Percentage**
Trepanation aspiration	9	75%
Aspiration + craniotomy	3	25%
Stereotactic aspiration	0	0%

Clinical Outcomes

The overall clinical outcomes in our series were favorable in the majority of cases. A favorable evolution was observed in 58% of patients (n = 7), reflecting good clinical recovery following combined medical and surgical management. However, an unfavorable outcome was noted in 42% of cases (n = 5), indicating the persistence of neurological deficits or complications despite treatment. These findings highlight that, although mortality remains relatively low, brain abscess continues to be associated with significant morbidity, emphasizing the importance of early diagnosis and appropriate therapeutic intervention. **(Table V).**

Table V. Clinical Outcomes

Outcome	**Number**	**Percentage**
Favorable	7	58%

Outcome	Number	Percentage
Unfavorable	5	42%

Unfavorable Outcomes and Complications

Among patients with unfavorable outcomes, recurrence was the most frequent event, observed in 42% of cases (n = 5), suggesting either incomplete resolution or persistence of infection. Notably, no immediate postoperative complications were recorded in our series. Mortality was low, with only one reported death (8%), which may reflect the effectiveness of the management strategy employed. These results underline the need for close follow-up and rigorous monitoring to detect recurrence early and improve long-term outcomes. **(See Table VI).**

Table VI. Unfavorable Outcomes and Complications

Parameter	Number	Percentage
Complications	0	0%
Recurrences	5	42%
Death	1	8%

DISCUSSION

Brain abscess remains a challenging clinical entity, particularly in resource-limited settings where delays in diagnosis and treatment are frequent. The findings of our study provide valuable insights into the epidemiological, clinical, and therapeutic characteristics of this condition in our context.

First, regarding epidemiology, our study confirms that brain abscess predominantly affects young adults, with a mean age of 28 years. This observation is consistent with previous studies reporting a peak incidence between the second and fourth decades of life [6]. The male predominance observed in our series is also widely reported in the literature, although the underlying mechanisms remain poorly understood and may involve behavioral or environmental factors [3].

From a clinical perspective, the presentation of brain abscess in our cohort was dominated by focal neurological deficits and signs of intracranial hypertension. Notably, the classical Bergman triad was not consistently observed, which aligns with previous reports highlighting its limited sensitivity [3]. The high frequency of neurological deficits (80.5%) in our study may reflect delayed presentation or advanced disease at diagnosis, a common issue in developing countries.

Seizures were observed in a relatively low proportion of patients compared to the literature, where reported rates range between 25% and 35% [7]. This discrepancy may be related to the small sample size or differences in lesion localization.

The identification of the portal of entry is a critical step in the management of brain abscess. In our study, ENT infections were the most common source, which is consistent with numerous reports emphasizing the role of otogenic and sinus infections in the pathogenesis of brain abscess [8]. However, a proportion of cases remained without identifiable origin, highlighting the need for systematic and thorough etiological investigations.

Radiologically, contrast-enhanced CT scan remains the cornerstone of diagnosis, typically demonstrating a ring-enhancing lesion with surrounding edema [4,9]. In our series, CT scan provided a typical appearance in the majority of cases. MRI, although performed in only a limited number of patients, demonstrated high diagnostic accuracy, particularly in distinguishing abscesses from other intracranial lesions [4,9]. The limited use of MRI in our study reflects constraints in resource availability.

Microbiologically, our findings are consistent with the polymicrobial nature of brain abscess. The predominance of anaerobic bacteria and *Proteus mirabilis* aligns with previous studies [5,10]. This highlights the importance of initiating broad-spectrum empirical antibiotic therapy covering both aerobic and anaerobic organisms, followed by targeted therapy based on culture results.

Therapeutically, surgical drainage combined with antibiotic therapy remains the gold standard. In our study, trepanation aspiration was the most frequently used technique, accounting for 75% of cases. This approach is widely favored due to its relative simplicity, effectiveness, and lower invasiveness compared to craniotomy [8,10].

Craniotomy was reserved for selected cases, particularly those with poor response to initial treatment or unfavorable abscess characteristics.

From a prognostic standpoint, our results emphasize the importance of early diagnosis and prompt management. Although mortality was relatively low in our series, morbidity remained significant (40.6%), reflecting the potential for long-term neurological sequelae. Previous studies have identified several prognostic factors, including low GCS at admission, immunosuppression, and delayed treatment [3,6].

Interestingly, some studies suggest that the choice of surgical technique may not significantly influence long-term outcomes, provided that effective drainage and infection control are achieved [6,10]. This highlights the importance of individualized treatment strategies based on patient characteristics and available resources.

Finally, our study has several limitations that should be acknowledged. The retrospective design and small sample size limit the generalizability of our findings. Additionally, the limited availability of advanced imaging and microbiological techniques may have influenced diagnostic accuracy.

Despite these limitations, our study provides valuable data on brain abscess management in a resource-limited setting and underscores the need for improved diagnostic and therapeutic strategies.

Limitations

This study has limitations including its retrospective design, small sample size, and limited access to advanced diagnostic tools, which may affect generalizability.

Strengths

This study provides real-world data from a resource-limited setting and integrates clinical, radiological, and therapeutic aspects, reflecting consistent management.

Clinical Implications

Early diagnosis is essential. CT scan remains a key tool. Combined medical-surgical treatment is effective. Prevention of ENT infections is critical.

CONCLUSION

Brain abscess remains a serious and potentially life-threatening condition, particularly in resource-limited settings where delays in diagnosis are common. Despite advances in

neuroimaging and therapeutic strategies, it continues to be associated with significant morbidity.Early diagnosis based on clinical suspicion and prompt imaging is essential to improving outcomes. The combination of appropriate antibiotic therapy and timely surgical intervention remains the cornerstone of management.

Preventive measures, particularly early treatment of ENT infections and increased awareness among healthcare professionals, are crucial to reducing incidence. Continued efforts are needed to improve access to diagnostic tools and optimize patient care.

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