



Original Article

Pediatric brain abscess – etiology, management challenges and outcome in Lagos Nigeria

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ABSTRACT

Background: Brain abscess in children is a neurosurgical emergency with potentially catastrophic outcome despite the advances made in neuroimaging techniques and antibiotic therapy. Symptoms are nonspecific and may vary with the child's age, location, size, numbers and stage of abscess, and the primary source of infection. Treatment is usually with broad-spectrum antibiotics in combination and surgical evacuation in most cases or antibiotics alone in selected cases with clear-cut indications. This study was to document clinical characteristics, etiological factors, and spectrum of bacteriologic agents responsible for pediatric brain abscess in an African city, the challenges and management outcome over the study period.

Methods: This was a retrospective study over an 11-year period involving 89 children who presented with brain abscess. Information of interest was extracted from the medical records of each participant. The results from data analysis were presented in charts and tables.

Results: Eighty-nine children aged 0.85–15.7 years (median age of 6.4 years) met the inclusion criteria. The male-to-female ratio was 1.8:1. Headache (80%), fever (78%), and hemiparesis (78%) were the most common symptoms. Brain imaging deployed was CT scan in 56 (63%), MRI in 9 (10%), and transfontanel ultrasound scan in 24 (27%) children. Seventy-one (80%) children had antibiotics with surgical evacuation while 18 (20%) children received only antibiotics. In 19 (27%) children, the culture of the abscess was negative. In 53 (75%) children, Gram-positive aerobic organisms were isolated. A total of 75 patients (84%) had a favorable outcome.

Conclusion: Pediatric brain abscess still poses significant public health challenge, especially in resource-limited regions. Successful management of brain abscess requires high index of suspicion for early diagnosis, referral, and intervention.

Keywords: Africa, Antibiotic, Brain abscess, Children, Gram-positive aerobes

INTRODUCTION

Despite the significant decline in mortality rate with advancements in diagnostic imaging and neurosurgical techniques, brain abscesses remain a potentially fatal central nervous system infection. Published literature reveals that approximately 25% of all brain abscesses are seen in childhood,

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mostly in the age group of 4–7 years.^[28,36,45] The decline in the mortality rate of brain abscess from 30% to 60% in the 1970s and 1980s to 4–24% in recent years has been attributed to improvement of hygiene and vaccination in pediatric population, advances in diagnostic imaging leading to early diagnosis, improved and rapid neurosurgical intervention techniques, and broad-spectrum antibiotics covering both aerobic and anaerobic organisms.^[7,11,22–24,28,33,35,36,44,45]

Brain abscess may be asymptomatic at the early stage. Clinical findings may be unspecific, mild or severe, and may be influenced by the patient's age, the stage, size and location of abscess, presence of meningitis, and patient's immune status.^[12,14,15,18,28,36,45] The classic triad of headache, fever, and focal neurologic deficit is seen in only 9–28% of children.^[28,36,45] Most commonly, these patients present with some degree of altered level of consciousness.^[3,10,14,28,33,36,45] The majority of brain abscesses are associated with congenital heart defects, infections in the head-and-neck region, and dental and neurosurgical procedures.^[3,13,15] The presence of immunosuppressive illness increases the risk of formation of brain abscess.^[3,5,11,28,33,36,45]

The main microorganisms responsible for brain abscess are aerobic and anaerobic streptococci and staphylococci. Others are *Bacteroides* species, *Proteus* species, *Haemophilus influenzae*, *Escherichia coli*, *Citrobacter* group, *Nocardia*, *Aspergillus*, and *Corynebacterium* species and *Mycobacterium tuberculosis*.^[3,10,14,33,36,41,45] Sterile cultures were in ranges of 10–56% in published literatures.^[5,12,18,28,33,36,41,45]

A combination of broad-spectrum or organism-specific antimicrobial therapy and surgical drainage is the preferred therapeutic method in most cases. Antimicrobial therapy alone is used for small-sized lesions usually <2.5 cm, multiple abscesses, and deep-seated lesions.^[12,14,27,28,34,36,45]

The objective of this study was to determine the clinical characteristics, predisposing factors, and management challenges and outcome of brain abscess in children treated in an urban African city over an 11-year period.

MATERIALS AND METHODS

This retrospective study included children with cerebral abscess treated in three facilities between January 2006 and December 2016. Lagos state is the most densely populated state in Nigeria with multiethnic and multinational representations. It is the economic capital of Nigeria with a population of over 18 million. Ethical clearance was obtained from the relevant authority (Reference No ADM/ DCST/ HREC/APP/1977).

Brain abscess was defined as a single or multifocal lesion located in the cerebrum, cerebellum, or midbrain, identifiable on computerized tomography (CT), magnetic resonance imaging (MRI) scan, or transfontanel ultrasound scan (TFUSS) which met at least one of the following criteria:

- Neuroradiological findings suggesting brain abscess with clinical response to antimicrobial therapy
- Purulent material within the defined lesion at surgery
- A positive culture of intracerebral material
- Microscopic or histologic features of an abscess.

The age, gender, clinical features at presentation, the locations and the causes of the abscesses where identified, and laboratory findings were recorded. Patients were either treated with antibiotics alone if the sizes were <2.5 cm or deep seated or antibiotics combined with surgical drainage if abscesses were large and readily accessible. In those with multiple abscesses, the large collections were drained and antibiotics continued. Surgical drainage was by craniotomy, burr hole, or percutaneous transfontanel aspiration. All aspirates were sent for Gram staining, culture, and sensitivity. Percutaneous aspiration was followed by CT scan or TFUSS and if the abscess increased in size postaspiration, it was repeated.

The results of microscopy, culture, and sensitivity of aspirates and abscess materials were documented. The treatment modalities, including surgical techniques, type and duration of antibiotic therapy, complications, and outcomes, were documented. The Glasgow Outcome Scale was used to determine favorable and unfavorable outcome.

RESULTS

Demographics

Eighty-nine children were included in this study, age 0.85–15.7 years (median age of 6.4 years). The average admission rate was nine cases/year. There were 57 males and 32 females with a male-to-female ratio of 1.8:1. Sixty-eight children (76%) were younger than 10 years of age.

Clinical features

The duration of symptoms ranged from 19 to 92 days with a mean of 37.6 days. [Table 1a] shows the presenting features and their frequency in this series. The most frequent features at presentation were headache (80%), fever (78%), hemiparesis (78%), altered level of consciousness (63%), and meningismus (57%). Headache and fever being unspecific symptoms led to the children receiving empirical treatment for malaria or meningitis before diagnosis of abscess was made. Thirty-nine of 89 children (44%) had a history of seizure. Fifty-six children (63%) presented with altered sensorium. This included the 22 children (25%) that had speech impairment of varying degrees. The Glasgow Coma Score (GCS) was 13–15 in 22 of 89 children (24%), 10–12 in 25 children (28%), and <10/15 in 9 (10%). Visual impairment was seen in 15 children (17%). These were mostly older children. The classical triad of fever, headache, and focal neurologic deficit was seen in 31 children (35%).

Table 1: Clinical profile and bacteriology of children with brain abscess.

Variables (total number, n=89)	Frequency (%)
a) Symptoms and signs	
Fever	69 (77.5)
Headache	71 (79.8)
Nausea-vomiting	48 (53.9)
Altered consciousness	56 (62.9)
Seizures	39 (43.8)
Meningismus	51 (57.3)
Hydrocephalus	23 (25.8)
Hemiparesis	69 (77.5)
Cranial nerve palsy**	38 (42.7)
Hypertonia/spasticity	25 (28.1)
Speech difficulties	22 (24.7)
Visual impairment	15 (16.9)
b) Etiological (predisposing) factors	
Cyanotic congenital heart disease	9 (10.1)
Otogenic	7 (7.9)
Meningitis	27 (30.3)
Sinusitis	4 (4.5)
Immunosuppression/HIV	9 (10.1)
Pulmonary origin (pneumonia)	9 (10.1)
Orbital cellulitis	2 (2.2)
Neurosurgical procedures	2 (2.2)
Unknown	20 (22.5)
c) Pathogens** (n=71 surgeries)	
A) Aerobes	
I) Gram-positive cocci	
i. <i>Streptococcus</i> spp.	
1. <i>Streptococcus viridans</i>	6
2. <i>Streptococcus pneumoniae</i>	12
ii. <i>Staphylococcus</i> spp.	
1. <i>Staphylococcus aureus</i>	13
2. Coagulase-negative staph	8
3. MRSA	1
II) Gram-negative organisms	
1. <i>Proteus mirabilis</i>	3
2. <i>Klebsiella pneumoniae</i>	5
B) Anaerobes	
I) Gram-positive cocci	
1. <i>Peptostreptococcus</i>	3
2. <i>Peptococcus niger</i>	5
II) Gram-negative bacilli	
1. <i>Fusobacterium</i> spp.	4
2. <i>Bacteroides</i> spp.	6
C) Negative pus culture (sterile)	19

There were multiple organisms in 11 cases. MRSA: Methicillin-resistant *Staphylococcus aureus*

Etiological/predisposing factors

The underlying diseases or predisposing factors are listed on [Table 1b]. The etiological factor was not known in 20 children (23%). Sixty-nine children (78%) had identifiable risk factors, the most common being meningitis (30%),

cyanotic congenital heart disease (CHD) (9), pulmonary infections (9), and immunosuppression/HIV, each contributing 9 patients (10.1%) of the etiological factors. Others were otogenic infections (8%), sinusitis (5%), orbital cellulitis (2%), and neurosurgical interventions (2%). Of the nine children with CHD, two had tetralogy of Fallot, two had pulmonary atresia, one had ventricular septal defect, and one had tricuspid atresia, while the type of CHD was not specified in three others.

Diagnostic imaging and abscess characteristics

Radiologic diagnosis was made using CT scan in 56 (63%) children, (MRI) in 9 (10%), and TFUSS in 24 (27%) children. There were solitary abscesses in 63 (71%) and multiple abscesses in 26 children (29%). The abscesses were located in the supratentorial region in 69 children (78%), infratentorial in 7 children (8%), and in both regions in 9 children (10%). Of the total of 78 abscesses observed in the supratentorial region, 39 (50%) were on the left, 27 (35%) on the right, and 12 were bilateral. Some multiple abscesses affected only one hemisphere. Of the 63 cases of solitary abscesses, 62 were supratentorial, only one was infratentorial in location. Information on the specific lobe involved in each hemisphere was lacking. The multiple abscesses in the infratentorial region (15) affected the left side (6) more than the right (4) and were bilateral in five cases. The number of multiple abscesses ranged from 2 to 11.

Microbiology

Seventy-one (80%) children had surgical evacuation of the abscesses, of which 15 (21%) had negative cultures [Table 1]. Aerobes were isolated in 53 (75%) cases, 20 (28%) of them were *Streptococcus* species, 23 (32%) of *Staphylococcus* species, and 10 (14%) cases of Gram-negative aerobes. Anaerobes were isolated in 12 (17%) cases. The most common organisms isolated were *Staphylococcus aureus* (15; 21%) and *Streptococcus pneumoniae* (14; 20%). The other organisms are as listed on [Table 1c]. There were multiple cultures in 11 children and one case of methicillin-resistant *S. aureus* (MRSA).

Treatment

Drug therapy

All patients had parenteral antibiotics for a minimum duration of 4 weeks. Total duration of antibiotic therapy was 6–8 weeks. Unless otherwise dictated by sensitivity pattern, the most common antibiotics used were cefotaxime (or ceftriaxone), amikacin (or gentamycin), and metronidazole based on presumed etiologic agent. Vancomycin was used in the patients with MRSA or as

indicated by sensitivity pattern. Other antibiotics used were meropenem, cefuroxime, cefpodoxime, and cotrimoxazole. Treatment was tailored in a multidisciplinary mode, to treat both the abscess and the source in each case. Additional procedures if required were performed by the comanaging team.

Eighteen patients (20%) received antibiotics alone while 71 patients (60%) had antibiotics and surgical drainage [Table 2]. Corticosteroid (dexamethasone) was administered to patients who had significant perilesional edema and considerable mass effect (midline shift on cranial imaging) at presentation or in the perioperative period for 3–5 days but not more than 7 days. Additional treatments given included antiepileptic drugs, physiotherapy, and speech therapy.

Procedures

Of the 71 patients who had surgery, percutaneous aspiration was used in 19 patients (27%), burr-hole craniostomy in 43 (61%), and craniotomy in 9 children (13%) [Table 2].

Capsule excision is not routinely done at craniotomy, but three of the nine cases treated by craniotomy had partial capsule excision because they were located close to the surface.

In all cases, abscess cavity was irrigated with saline containing antibiotics. Gentamycin is our antibiotic of choice for irrigation but some cases were irrigated with vancomycin and additionally metronidazole. We did not record any case with ventricular rupture, so ventriculostomy was not needed in any of the patients in this series.

Outcome

A total of 75 patients (84%) had a favorable outcome: 54 (61%) had full recovery, 12 (14%) had mild deficits, and

9 (10.1%) had moderate deficits. Of the 14 (16%) who had unfavorable outcome, 8 (9%) died during admission while 6 (7%) had severe deficits [Table 2]. These fatalities and severe deficits were documented in patients who had delayed presentation, with poor GCS at presentation due to financial constraints. Consequently, diagnosis and intervention were delayed leading to poor outcome.

DISCUSSION

With the introduction of modern imaging, antibiotics, and stereotactic surgical techniques, the outcome of brain abscess has dramatically improved.^[5,22,25,28,36,40,44] Despite the decline in mortality, brain abscess remains a serious illness that can result in severe morbidity or even mortality, especially if misdiagnosed, diagnosed late, or managed inappropriately.^[6,14,23,28,33,40,43]

This study of 89 children with an average of 8.1 cases/year has higher incidence than the series published from Turkey, Korea, and the USA with a range of 1.67–2.7 cases/year.^[5,21,37] A median age of 6.4 years is closer to the series in Turkey.^[5,28] Delayed presentation is evident in this study with a mean duration of 37.6 days and symptoms lasting up to 92 days before presentation. This is comparable only to the study by Atiq *et al.* in India (sharing similar technological challenges with many parts of Africa) with delayed presentation of up to 120 days.^[2] There are no data on incidence rate of brain abscess in Nigeria at the moment. In a Tunisian multicenter study involving 41 children over a 19-year period, the mean age was 4.9 years.^[26]

Clinical findings in children are mostly nonspecific, especially in the younger age group.^[12,14,18,28,36,45] The clinical features in our series of frequency were headache, fever, hemiparesis, altered consciousness, meningism, nausea, vomiting, seizures, cranial nerve palsy, and hydrocephalus. Headache and fever being nonspecific symptoms were seen in 80% and 78%, respectively, in our series. The triad of fever, headache, and vomiting in this study was more than seen in the Tunisian study.^[26] Fever is a common condition in many childhood illnesses.^[9] Most of the patients first received empirical therapy for malaria, an endemic condition in Sub-Saharan Africa, often presenting with pyrexia and headache, and might have coexisted with the brain abscess. This may account for the higher frequency in this series compared to most published series in children.^[8,12,13,18,27,28,36] Seizure (partial or generalized) was present in 39 (44%) of the children in this series. Lee *et al.*^[21] observed seizures in 48% of the patients in their series in Korea. Atiq *et al.*^[2] observed seizures in 45% in their series from India. Seydoux and Francioli^[35] observed that 25% of their patients presented with seizures as the first clinical manifestation of brain abscess.

There was no established predisposing factor in 20 (23%) of 89 children in this series. In published studies, this ranges

Variables	Frequency (%)
Treatment offered	
Antibiotics only	18 (20.2)
Antibiotics+surgery	71 (79.8)
Type of surgery (n=71)	
Percutaneous aspiration	19 (26.8)
Burr-hole craniostomy	43 (60.6)
Craniotomy	9 (12.7)
Outcome (GOS) n=89	
5 – No deficit	54 (60.7)
4 – Mild deficit	12 (13.5)
3 – Moderate deficit	9 (10.1)
2 – Severe deficit	6 (6.7)
1 – Dead	8 (8.99)

GOS: Glasgow outcome score

from 8.3% to 40%.^[1,2,5,21,27,30,36,43] In 69 children (78%) with identifiable risk factors, the most frequent was meningitis (30.3%), followed by CHD, pulmonary infections, and immunosuppression (from HIV/AIDS and childhood malignancies with chemotherapy), each occurring in 9 (10%) children. Many studies in literature found CHD to be the most common etiological factor accounting for 25–46%.^[1-3,5,18,28,29,31,39,44] In other studies, suppurative otitis media was a major contributing etiologic factor.^[8,10,21,36] In our study, CHD was responsible for 10% of abscess in children. The failure to diagnosis and treat CHD in developing world could lead to majority of them dying before intervention. Ignorance and lack of facilities accessible to the parents, especially in the rural area, may account for failure to diagnose and treat CHD. The evolution in antibiotic therapy has also led to effective treatment of otitis and sinogenic infections, and prophylactic antimicrobial therapy for CHD patients resulting in fewer complications.^[10,13] Immunosuppressed children are often on treatment for HIV/AIDS and hematological malignancies, or organ transplant.^[10] None of the children in this series had organ transplantation.

Imaging diagnosis was done with CT scan, TFUSS, and MRI in the ratio of 6.2:1:2.7. The use of TFUSS has proven very useful in our region and has been used to diagnose various intracranial conditions.^[17] Ultrasonography was used in diagnosis of three of 25 cases reviewed in the study from Korea.^[21] They, however, did not state the reason for the use of TFUSS in some of their cases. The difference in percentage of cases diagnosed with ultrasonography is related to cost or affordability of the superior imaging techniques, especially in developing countries.^[17]

TFUSS is unable to accurately characterize the abscess or the count in multiple lesions and this contributed to paucity of the information regarding the number of abscesses in children who underwent this procedure. Because it is operator dependent, some of the information might have been missed out. However, TFUSS will characterize large solitary lesions (>2.5 cm in diameter) and lesions closer to the surface facilitating early diagnosis and therapy. TFUSS can be repeated severally without risk of exposure to irradiation.^[16,17] Ultrasonography was deployed in the management of majority of the patients in the cohort reported by Yang.^[44]

Our high rate of sterile culture is not uncommon. In several series, the culture-negative rate ranges from 10% to 56%.^[3,12,17,18,28,33,36,41,45] Negative cultures may be due to recent use of antibiotics as the case for many children in this series; this is accounted for by previous use of antibiotics, inadequate sampling techniques, and difficulty in isolating some fastidious microorganisms.

The most common micro-organisms in published literature, responsible for brain abscess are aerobic and anaerobic

streptococci and staphylococci.^[3,10,14,28,33,36,41,45] The treatment modality for brain abscess is still a subject of controversy in literature and indications are constantly being modified by new methods of minimally invasive therapy. Contemporary treatment is centered around antimicrobial therapy and surgical intervention. The choice of therapeutic approach depends on the stage of the abscess, the location, origin, the number of abscesses, the microorganism isolated, patient's immune status, the degree of cerebral edema, and available technological advances like image-guided minimally invasive surgery.^[4,12,18,19] Antibiotic therapy alone is the preferred choice if the abscess is deep seated and <2 cm in diameter, if there are multiple abscesses and if the patient's clinical status precludes surgery.^[12] Surgical drainage (aspiration or excision) is preferred if the abscess diameter is >2.5 cm or if there is a mass effect followed by 6–8 weeks of intravenous antimicrobial therapy.^[12,14,18,27,28,34,36,45] Stereotactic aspiration in combination with antimicrobial therapy or hyperbaric oxygen has been used to treat abscesses in difficult-to-reach areas such as the brain stem or eloquent areas and multiple abscesses, even in patients who are high surgical risk.^[4,14,19,20]

In this series, 20% of patients received antimicrobial therapy alone. This falls within the range of 10–24% in published literature.^[3,13,14,28] All the children who received only antimicrobial therapy had parenteral antibiotics for a minimum duration of 4 weeks.

Corticosteroid use in the management of brain abscesses has attracted controversies. Some authors have opined that steroid use is associated with increased morbidity and mortality.^[14,46] Corticosteroid use has been linked with decreased antibiotic penetrance, inhibition of leukocyte migration, delayed capsule formation with increased risk of intraventricular rupture, and reduction of host defense.^[24,46] However, a recent meta-analysis suggested that administration of dexamethasone does not increase mortality in brain abscesses treated with antibiotics.^[38]

Sixty-two (87%) of the 71 patients who had surgical intervention received minimally invasive procedures, while only nine patients had craniotomy. Percutaneous aspiration was performed in 19 patients while burr-hole craniostomy was used in 43 patients. Stereotactic techniques are not yet available in our center. The use of craniotomy for the treatment of abscess has significantly decreased while minimally invasive or image-guided aspiration techniques are now preferred as first surgical choice for abscesses.^[32,42]

Outcome in this study was unfavorable in 16% with a mortality rate of 9% [Table 2]. The deaths were due to delayed presentation, diagnosis, and intervention often attributable to poverty and ignorance.^[16,17] This is common in resource-poor countries and radical changes in the health system and public education are necessary to reverse this trend. The health insurance coverage is still very low in Nigeria.

A mortality rate of 9% falls within the range published in literature.^[14,22,23,28,36,40]

CONCLUSION

Brain abscess is common in children with high incidence of morbidity and mortality often related to late presentation and therefore still poses a public health challenge in resource-limited regions. Successful management of childhood brain abscess with acceptable outcome is dependent on early diagnosis and intervention, the rational use of antimicrobial therapy, and adaptation of available technology. Despite the fact that Lagos has a multiethnic and multinational population, authors acknowledge that medical and demographic variations exist between countries.

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Declaration of patient consent

Institutional Review Board (IRB) permission obtained for the study.

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Conflicts of interest

There are no conflicts of interest.

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