

Original Article

## Brain Abscesses in Children: A Study of Microbiological Spectrum and Outcome of 80 Cases

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### ABSTRACT

**Objective:** Brain abscess is a focus of pus in the brain due to infection somewhere else in the body. It is common in males than females and the average age in children ranges from 4 to 7 years. It develops by skull trauma or contiguous or hematogenous spread of infection. The study aimed to identify the pattern of microbiological involvement in the etiology of pediatric brain abscesses and the outcome so as to enable us to ensure definitive treatment with the appropriate and specific antimicrobial regimen.

**Materials and Methods:** A prospective study was conducted in 80 pediatric patients of brain abscess admitted to the Pediatric Neurosurgery Department, Children Hospital, Lahore, Pakistan.

**Results:** The median age was 5.2 years with a predominance of males (60%). The most common presentation was fever (72.5%) and then fits (35%). Congenital heart disease was the commonest factor in 32% of cases. Streptococcus was a commonly isolated pathogen in 17% cases out of 70% of culture positive cases. Recovery was seen in 70% of cases and the mortality was 7.5%.

**Conclusion:** Congenital heart disease is the most common causative factor in pediatric brain abscesses and most of the abscesses were found culture negative. There is a pressing need to carry out multicenter studies over a large sample size over extended study duration in developing countries to help establish guidelines in treating pediatric brain abscesses.

**Keywords:** Brain abscess, children, microbiological spectrum, outcome, congenital heart disease.

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### INTRODUCTION

A brain abscess is a collection of pus that occurs in the brain due to a focal point of infection somewhere else in the body. Brain abscesses are seen more commonly in the male population than females and the average age in children ranges from 4 to 7 years.<sup>1</sup> Brain abscesses may develop due to various pathogens<sup>2,3</sup> and the most common microbes are viruses and bacteria.<sup>4</sup> Brain

abscess is less common in children than adults but still may be a fatal condition.<sup>5</sup> The commonest isolated pathogens are anaerobes, aerobic streptococci, and *Staphylococcus aureus*.<sup>6</sup> Enterobacteriaceae, *Pseudomonas aeruginosa*, *Candida*, *Aspergillus* fungi, and *Mycobacteria* are found in immunosuppressed.<sup>7</sup> Brain abscesses can develop by contiguous or hematogenous spread of an infection or by trauma to the skull. The causative factors for developing an abscess include congenital heart disease, infective endocarditis, skull fracture, infections in ear, teeth or sinuses, shunts, and immunocompromised states like HIV and chemotherapy.<sup>8</sup> Local sources of contiguous spread include infections in dental mucosa, ear, sinuses, and mastoid cavity.<sup>9,10</sup> Vaccinations and empirical antibiotics has decreased the role of otitis media in causing abscesses.<sup>11</sup>

Brain abscess commonly presents with fever, vomiting, and headache due to raised intracranial pressure. Seizures, altered consciousness, and symptoms of focal neurological deficit may also occur.<sup>6</sup> Early detection and treatment is essential to prevent fatal complications like septicemia, ventriculitis and pneumonia.<sup>12</sup>

After routine laboratory and radiological investigations CT (computed tomography) scan with contrast followed by Magnetic resonance imaging MRI (magnetic resonance imaging) enables accurate diagnosis of site, number, and size of the abscess and also helps in aspiration for pus culture to detect the pathogen.<sup>13</sup>

Management of the brain abscess includes high dose intravenous empiric antibiotics like ceftriaxone and metronidazole,<sup>15</sup> symptomatic therapy for fits. Abscess larger than 2.5 cm is aspirated or excised.<sup>16</sup> Resection of abscess cavity after craniotomy is done if the abscess does not respond to burr hole aspiration or multiple contiguous small abscess cavities causing raised intracranial pressure.<sup>17</sup> Delayed or poor response to empiric antimicrobial therapy warrants some

uncommon or atypical pathogens which might be involved in the etiopathogenesis of brain abscess.

Clinical course may vary from indolent to fulminant over a period of seven to ten days which can be improved by early management to prevent the progression from cerebritis to abscess.<sup>18</sup> The current study was focused to identify the pattern of microbiological involvement in etiology of brain abscesses and respective outcome in the pediatric population so that we may be able to ensure definitive treatment with appropriate and specific antimicrobial regimen. Moreover, currently available studies have a small sample size which was more in our study than that of previous ones.

## **MATERIALS AND METHODS**

### **Study Design & Setting**

It was a prospective observational study with a sample size of 80, selected by non-probability purposive sampling from pediatric patients admitted with a diagnosis of brain abscess. The study was conducted at the Pediatric Neurosurgery department, Children Hospital & Institute of Child Health, Lahore, Pakistan for a period of one year from Oct. 2018 – Sept. 2019. The study was started after approval from the hospital ethical committee.

### **Inclusion Criteria**

We included patients aged less than 15 years of age with a CT scan/ultrasound/MRI confirmed brain abscess.

### **Exclusion Criteria**

Patients having extradural abscess, subdural pus collection, or an unknown abscess location were excluded.

### **Data Collection**

Patients were admitted to the pediatric

neurosurgery ward for proper management. Written and informed consent was taken from parents. All data like demographic details, clinical features, abscess location, microbiology results, surgical intervention, complications, and outcome were collected.

Burr hole or aspiration of pus from the abscess under ultrasound guidance or excision of the capsule with aspiration was done depending upon the size and number of abscesses. Samples for pus and culture sensitivity, gram staining, fungal staining, ZN (Ziehl Neelsen) staining, and blood culture were taken. Empiric antibiotics were given till the confirmation of the microbiological nature of pus drained from the abscess. Data was collected on a predesigned proforma.

### Data Analysis

All collected data was analyzed through SPSS (Statistical Package for Social Sciences) version 23. Means and the standard deviations were calculated and presented for numerical data like age. Categorical data like gender and clinical symptoms were presented as frequency and percentages. Chi-square was applied to see the association between variables. A P-value less than or equal to 0.05 was considered significant.

## RESULTS

A total of 80 children suffering from brain abscess were studied.

### Gender Distribution

Out of these, 48 (60%) were male and 32 (40%) were females. The male and female ratio was 3:2. The median age was 5.2 years.

### Clinical Presentation

The 58 patients (72.5%) had fever, 28 (35%) had fits, 26 (32.5%) had vomiting, 22 (27.5%) had focal

deficit, 20 (25%) had headache and 14 (17.5%) were unconscious (see Table 1).

### Location of Abscess

The most common location of the abscess was the frontal lobe which was 40% (n = 32). Other sites were the parietal lobe in 30% (n = 24), temporal lobe in 15% (n = 12), cerebellum in 10% (n = 8) and thalamus in 6.25% (n = 5).

### Number of Abscess

Sixty patients (75%) had a single abscess while twenty (25%) had multiple abscesses. As shown in Figure 1, Seventy-five patients (93.75%) had a recognizable source which included; infections of Ear Nose throat (ENT) (n = 12), congenital heart disease (CHD) (n = 26), pyomeningitis (n = 15), lung infection (n = 3), post-trauma (n = 5), and immune deficiency (n = 6).

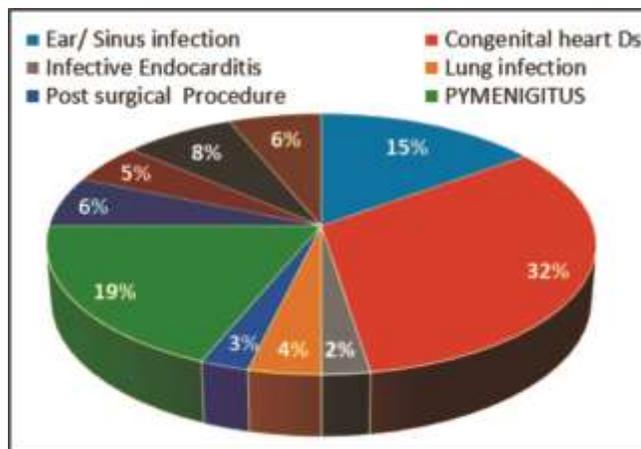
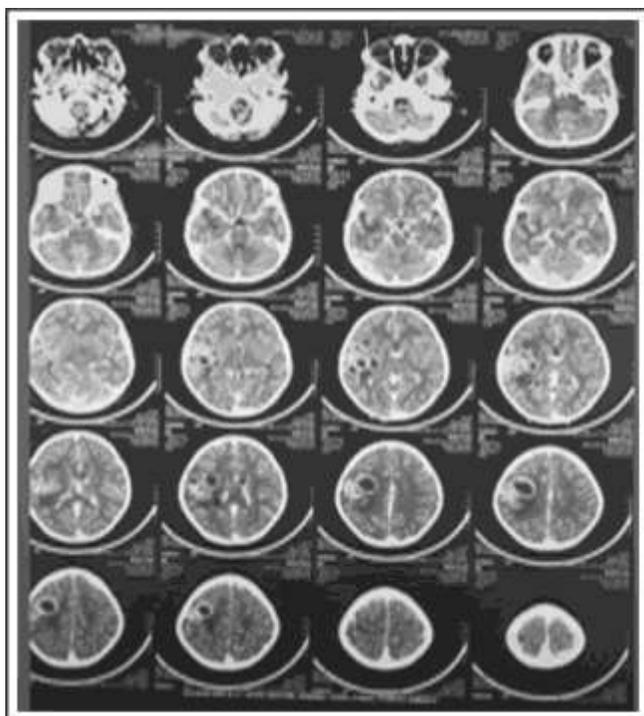
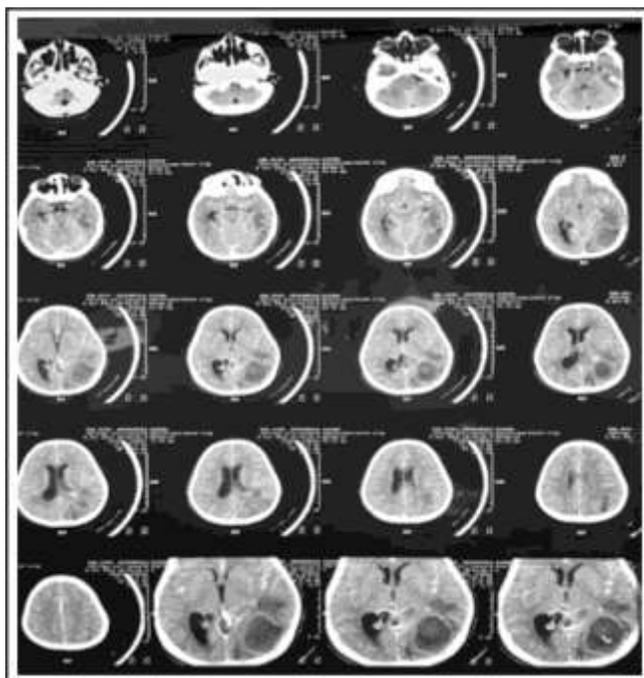


Figure 1: Predisposing factors for brain abscess.

Table 1 shows the pattern of various pathogens cultured from pus. Streptococcus and pseudomonas were the common pathogens isolated from the abscesses (n = 14, 17.5%) followed by Staphylococcus (n = 12, 15%) and Klebsiella (n = 10, 12.5%). No growth was seen in 24 cases (30%).



A



B

**Figure 2:** CT scan findings of abscesses. 2a: abscess in right parietal lobe, 2b: abscess in left occipital lobe.

**Table 1:** Microbiological Spectrum.

Name of Microbe	No. of Patients	Percentage
Streptococcus	14	17.5%
Staphylococcus	12	15%
MRSA	6	7.5%
Proteus	4	4%
Ecoli	4	4%
Klebsiella	8	12%
Citrobactor	2	2.5%
Acinetobactor	2	2.5%
Mycobacterium	2	2.5%
Fungal Hyphae	2	2.5%

Fifty-eight patients underwent surgery. Amongst patients with surgical intervention, Forty-six patients (57.5%) had single aspiration, four (5%) had multiple and eight (10%) underwent craniotomy (Table 2). Fifty six (22.5%) patients have recovered while six (7.5%) patients died (Table 3).

**Table 2:** Treatment Modalities given to treat abscess.

	No. of Patients	Percentage
Surgical Intervention	54	57.5%
Craniotomy	8	10%
Single Aspiration	46	57.5%
Multiple Aspiration	4	5%
No surgical intervention	22	27.5%

**Table 3:** Outcomes.

Outcome	No. of Patients	Percentage
Recovery	56	70%
Morbidity	18	22.5%
Death	6	7.5%

**Table 4:** Association between left temporal abscess and outcomes.

Outcome	Left Parietal Abscess	p-value
Recovery	6	0.100
Morbidity	2	0.461
Death	4	0.004

**Table 5:** Comparison with previous foreign & local studies.

Study	Sample size (n)	Median Age	Positive Pus Culture	Glasgow Outcome Score	Microbial Pathogen
Raffaldi et al <sup>33</sup> 2017	79	8.7 years	74%	Score 1 in 8%	Gram +ve Cocci
Lee et al <sup>32</sup> 2010	25	4.3 yrs	64%	Score 1 in 16%	Staphylococcus aureus
Khan IU et al <sup>27</sup> 2019	25	9 years	48%	Score 1 in 12%	Streptococci
Our study	80	5.2 years	70%	Score 1 in 7.5%	Streptococci

According to the results of Chi square (Table 4), a significant association (p value 0.004) existed between the left temporal abscess with outcome of death.

## DISCUSSION

A brain abscess is an encapsulated and localized infection in the brain that may be the result of untreated otorhinolaryngeal infection, congenital heart defects, or immunosuppression in most of the cases. The clinical course varies from indolent to fulminant depending upon certain factors like site, size, pathogen involved, location and treatment, etc.<sup>15</sup> In spite of the advances in diagnostic and treatment modalities, brain abscess is still related to significant morbidity and mortality, especially in the pediatric population. Our study was a part of this effort to see the commonest pathogen involved in the causation of brain abscess in children and to study the other factors in determining its outcome. Although, our country has a more female population, however, our study showed a predominance of males (60%) showing male-female the ratio of 3: 2. This correlates with a study conducted by Canpolat et al, who also found male predilection.<sup>19</sup>

The median age was 5.2 years, with the most frequent range of 1 – 4 years (47.5%). Only 17.5% were in the age range of 9 – 12 years. This showed more prevalence in infant and younger children than older ones. We observed no abscess in children below one year of age. These results are comparable with those of the study by Tfifha et al<sup>20</sup> in which the mean age was 4.9 years.

Another study by Shachar et al<sup>10</sup> found the mean age to be 7.9 years.

The most frequent presentation in our study was fever which was in 72.5% of cases followed by fits in 35% of cases and vomiting in 32.5% of cases. The classical triad was less commonly seen. A study by Shachor et al showed headache in 81% cases by fever in 78% cases.<sup>10</sup>

The commonest predisposing underlying condition in our study was congenital heart disease (32.5%) followed by pyomeningitis and ear/sinus infection (18.75% and 15% respectively). This also explains fever as the commonest presentation of our study which is a chronic complaint in most congenital heart disease patients. Mehmet et al<sup>24</sup> also found CHD as an important predisposing factor (20.7%) in Turkish children and Atiq<sup>25</sup> observed 37% cases of CHD in Pakistani children. These results show discordance with those in a study by Theresa S et al who found sinusitis & meningitis in 88% of cases as the commonest underlying factor.<sup>21</sup> Another study by Tfifha et al<sup>20</sup> also showed meningitis as a predisposing factor in 82.9% of cases. These differences between results may be due to variation in patients' recruitment and due to more malnutrition and immunosuppressed state in CHD which predisposes them to develop an abscess. This underlines the importance of early diagnosis of CHD to avoid the development of abscess later on and the need for proper management of malnutrition. CHD was a rare causative factor observed by Fabian et al in the UK who found sinusitis is the most common predisposing factor (42%) which was 15% in our study.<sup>22</sup>

Our study cases had more abscesses in the

left frontal and temporal lobe (25% and 15%) locations, which means origin from sinusitis or dental infection followed by those from acute otitis media, but very few were found in the thalamus (6%). Only 25% of our patients had multiple abscesses which are consistent with studies by Cole et al<sup>21</sup> and Chiara et al<sup>23</sup> which may be due to hematogenous spread from the outlying focus of infection.

Pus culture from abscess was positive in 70 % cases. Streptococci were the most commonly cultured pathogen (17%) while staphylococci were seen in 15% of cases. A study by Atiq in Karachi, Pakistan also showed streptococci as the commonest pathogen in 52% of cases with CHD.<sup>25</sup> Another local study (in Pakistan) by Nabeel et al also showed *Streptococcus milleri* in 2.7% of study population.<sup>26</sup> Khan et al<sup>27</sup> in Multan, Pakistan observed Positive culture in 48% in a study on 25 cases of pediatric brain abscess. Ashraf et al<sup>28</sup> reported 36% cases to be culture positive with streptococci growth.

*Streptococcus* was seen in 36% cases followed by staphylococci in 18% cases and gram-negative organisms in 16% in a study by Brouwer et al<sup>29</sup> while our study showed 22% cases with the growth of gram-negative organisms. Bhand et al<sup>30</sup> reported staphylococci as the commonest pathogen while in our study these were in 15% of cultures. In our study cases, Unusual pathogens like *Mycobacteria* were isolated in 2.5% of cultures and fungal hyphae also in 2.5% cases whereas these were found to present in less than 2% in the study by Brouwer et al.<sup>29</sup> This may be explained by less prevalence of immunosuppression in the American population as compared to ours which was 7.5%.

22 patients were managed conservatively in whom Glasgow coma scale (GCS) was mild, abscess size was less than 2.5cm and no mass effect was seen. The same protocol was recommended in studies by Chiara et al<sup>23</sup> and Arlotti et al<sup>31</sup>.

Craniotomy for excision of thick pus was

needed only in 10% (n = 8) as 57.5% responded to single aspiration. Thus we observed that it was possible to treat abscess by aspiration in most the cases rather than craniotomy with excision depending upon location, number, and size of abscess because aspiration is still associated with lower mortality than excision. Mortality in our study was 6 out of 80 cases which were calculated as Glasgow outcome score of 1 was in 7.5%. 4 out of these 6 cases were having abscesses in the left temporal lobes (p-value: 0.004), mortality was due to early herniation of cerebral unci and motor effects. Khan et al<sup>27</sup> observed 12% mortality in his study on 25 cases and Atiq et al<sup>25</sup> observed 16% mortality in the Pakistani population in the year 2005. The decrease in mortality percentage can be explained by advancement in early diagnosis of brain abscess and the use of effective empirical treatments. Table 5 shows a comparison of the results of our study with those of previous international and local studies.

### Strengths of Study

The sample size was more than previous studies therefore it provides additional data to them; further, this is first study of pediatric brain abscess cases conducted in Lahore which is located in Eastern Punjab. Settings of this study cover a wide range of areas from where the patients are referred thus included patients of various demographic and socioeconomic profiles.

### Limitations

It was a single-center study covering the population from central Punjab, Pakistan mostly. Microbiological spectrum and predisposing factors for brain abscess in children of other provinces of Pakistan was not studied.

We found no children under one year of age, therefore, factors in this age group still need to be studied by future studies.

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## CONCLUSION

Predisposing factors for brain abscess are variable in children. Congenital heart disease was found to be a commonest underlying factor in pediatric brain abscesses and most of the abscesses in congenital heart disease patients were found culture negative. Overall, the mortality rate was 7.5% which is still high in Pakistan. There is a pressing need to carry out multicenter studies over a large sample size overextended study duration in developing countries to help establish guide lines in managing brain abscess in children.

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### Additional Information

**Disclosures:** Authors report no conflict of interest.

**Ethical Review Board Approval:** The study was conformed to the ethical review board requirements.

**Human Subjects:** Consent was obtained by all patients/participants in this study.

**Conflicts of Interest:**

In compliance with the ICMJE uniform disclosure form, all authors declare the following:

**Financial Relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work.

**Other Relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

### AUTHORS CONTRIBUTIONS

Sr.#	Author's Full Name and Affiliation	Intellectual Contribution to Paper in Terms of:
1.	Faisal Feroz Rana	Study design and methodology, analysis of data and interpretation of results.
2.	Iram Javed	Paper writing, data calculations and analysis.
3.	Mazhar Mahmood	Study design and Data collection.
4.	Uzma Amin	Paper writing, referencing, manuscript writing and data collection.
5.	Muhammad Nadeem Malik	Interpretation of results, study design and methodology.
6.	Rizwan Masood	Data analysis and quality insurer.
7.	Rizwan Yaseen	Literature review, data analysis and calculations.