ORIGINAL ARTICLE

Clinical Characteristics and Outcome Assessment of Brain Abscess in Children and Adolescents; a 2 Years Neurosurgical Perspective

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ABSTRACT

Background: *Brain abscess is a serious infective disorder of the central nervous system with high rates of prolonged morbidity and mortality. Effective neurosurgical management is the key to lower morbidity and death rates due to this disease.*

Material and Methods: *This study was conducted prospectively at the Department of Neurosurgery, Hayatabad Medical Complex Peshawar from January 2013 to December 2014. Presenting clinical features, radiological characteristics and surgical findings were recorded. Emphasis was placed to test the effectiveness of prompt surgery, good antibiotic coverage and the use of drainage tubes in reducing recurrence rates and lowering morbidity and mortality. The patients were followed for one month postoperatively and their functional outcome plus radiological resolution recorded.*

Results: *48 cases were included in the study with 33 (68.8%) males and 15 (31.3%) females and mean age of 9.7 years (SD ± 4.5). Median GCS on presentation was 12 (SD ± 3.1) and mean diameter of the abscess cavity was 4.8 cm (SD ± 1.3). The mean of length of stay was 6.6 days (SD ± 2.7) while median GOS at discharge was found to be 4 (SD ± 1.2). Eighteen of the 48 patients were lost to follow up. Overall mortality was 14.6% (7 patients). There was a significant correlation between admission GCS and GOS at discharge ($r = 0.87$ and $p = < 0.001$).*

Conclusion: *The paediatric age group is more susceptible to central nervous system infections and cerebral abscess development. Moreover, the higher prevalence of congenital heart diseases, pulmonary disorders and head trauma leads to higher incidence, prolonged morbidity and increased mortality. Surgical interventions for brain abscess have good outcome. However, early diagnosis is the key to saving lives.*

Keywords: *Paediatrics, Central Nervous System, Infection, Brain Abscess, Bacterial.*

Abbreviations: *GCS: Glasgow coma scale, GOS: Glasgow Outcome Scale, LOS: Length of Hospital Stay.*

INTRODUCTION

Brain abscess is a focal intracranial infection which evolves from local cerebritis to late stage abscess formation surrounded by a vascular capsule. The incidence rate in United States is reported to range from 0.3 to 1.3 cases per 100,000 persons per year while it accounts for 8% of all the intracranial mass lesions encountered in the developing countries.[1] The male to female ratio is reported to be in the range of 2:1 to 3:1 while the most commonly affected age group is 20 to 30 years.[1,2] Brain abscess in the paediatric and adolescent age groups account for more than 25% of all the brain abscess cases with the majority of cases resulting as complications of conditions like chronic otitis media (CSOM), congenital heart diseases (CHD), trauma and rarely surgery.[3,5] Brain abscess is reported to be the complication of CSOM in more than 40% of cases while congenital heart diseases accounts for another 40% in children. The mortality from this condition is reported to reach up to 29%.[3,4,7]

Cerebral abscess has been identified to run through four stages of evolution namely; i) early cerebritis, ii) late cerebritis, iii) early capsule formation and iv) late capsule formation. The most common predispos-

ing condition for development of a brain abscess is a focus of a nearby infection which then extends intracranially by invading the intervening tissue structures.[6]

Clinical features of cerebral abscess are non-specific and widely variable. The most commonly reported characteristics are headache, vomiting, decreasing level of consciousness and focal neurologic deficits.[7] However, the classic triad of fever, headache and leucocytosis is frequently reported to be absent. MRI is the investigation of choice for diagnosis as well as preoperative planning. CT scan with and without contrast is also a widely available radiological investigation with good sensitivity and specificity.[8,10]

The treatment of bacterial brain abscess involves the use of antibiotics and surgical aspiration or excision. The optimal antibiotics regimens indicate the use of high dose intravenous antibiotics for 6 to 8 weeks with biweekly CT scan follow up and after that continuation with oral antibiotics for 2 to 3 months.[9]

Current clinical guidelines indicate that abscesses with more than 2.5 cm diameter should be either excised or drained. The most commonly employed surgical technique is to aspirate the abscess using a brain cannula with or without radiologic guidance. However, there is increasing concerns over the increased rates for recollection and the need for repeat interventions. Nonetheless, aspiration is more favoured due to its less invasive nature, shorter procedure times, effectively obtaining material for microbiological assessment and relative efficacy in terms of less neurologic deficit after surgery. Currently there is no available data from a randomised controlled trial evaluating open excision or aspiration and the absolute effectiveness of one procedure over the other.[1,9,10] Various strategies have been employed in order to reduce the recollection and recurrence rates after aspiration. One of these include the use of drainage tubes inside the abscess cavity and draining the collection with regular intervals and it has shown promising results in terms of shorter hospital stay, lower mortality and shorter hospital stay.[11]

MATERIAL AND METHODS

The study was conducted prospectively at the Department of Neurosurgery Hayatabad Medical Complex Peshawar from January 2013 to December 2014 after approval from the institute's ethical committee. After taking informed consent from the patients or their parents/guardians, all patients male or female with age range of 1 to 18 years and with a diagnosis of brain abscess were included in the study. The data was collected on a predesigned pro forma.

CT scan with contrast and MRI Brain with contrast were performed in order to establish the diagnosis and management plan. Size (diameter) of the abscess cavity was measured in centimetres as shown by the imaging studies. Abscesses with a diameter of more than 2.5 cm were scheduled for surgery.

- Data was collected about the patients' age, gender, address, duration of symptoms and any comorbid conditions.
- Presenting complaints were recorded for presence or absence of headache, fever, vomiting, fits and on clinical examination the Glasgow coma score, examination of the fundi and presence or absence of neurologic deficits were recorded.
- The findings on MRI brain and CT scan were recorded. Note was made about the intracranial location of the abscess, diameter in centimetres, associated midline shift, number of the lesions and the presence or absence of hydrocephalous.
- After diagnosis appropriate antibiotics regimen was instituted. In most of the cases the antibiotics were initiated preoperatively. These included three antibiotics drugs, namely; Metronidazole + One 3rd generation Cephalosporin + One Aminoglycoside (or as indicated by the culture and sensitivity reports).
- Initial surgical procedure was decided to be aspiration in all cases except for those with abscess due to foreign bodies. Postoperatively the patients were followed with serial contrast enhanced CT scans after every 24 hours for the first 72 hours. Any significant recollection which required repeat aspiration was operated.
- Abscesses with large volumes and increased midline shift were also treated with insertion of a size 8 tube inside the abscess cavity. The tube was used for aspiration of the recollection after 24 hours. Those abscesses which were not amenable to aspiration for two consecutive times were listed for open excision of the abscess capsule using craniotomy. The rates for reoperation and recollection were recorded.
- Postoperative complications, mortality, recollections and readmissions were recorded.
- At first discharge the Glasgow outcome score (GOS) was calculated to see the functional level.
- Patients were followed for one month and their GOS was assessed.

- Contrast enhanced CT Brain was used to assess for resolution of the abscess cavity.

Data was analysed using SPSS version 20.0. Pearson's chi-square and Fischer's exact test and multiple logistic regressions were used as appropriate.

The GCS on admission was grouped into good or poor neurologic status. Patients with a GCS of > 12 were grouped as having good neurologic status while patients with admission of 12 or less were grouped as having poor neurologic status.

The primary outcome measures were mortality after admission date and GOS at discharge. A p-value of less than 0.05 (two – sided) was considered significant.

Finally, Chi Square analysis was performed for all the categorical variables and Pearson's correlation and Odds ratio was calculated in relation to the outcome variables of GOS at discharge and mortality. Similarly, the effect of the use of tube drainage was analysed for the frequency of recurrence and results compared with the group where no tube drainage was used.

RESULTS

Sex Incidence

During the 2 year period, a total of 48 patients were included in the study with 33 (68.8%) males and 15 (31.3%) females.

Age Incidence

The mean age was 9.7 years (SD ± 4.5).

Clinical Presentation

The mean duration from onset of symptoms to presentation was 15.1 days (SD ± 6.5) while the mean diameter of an abscess on imaging was 4.8 cm (SD ± 1.3). Average length of hospital stay (LOS) was found to be 6.6 days (SD ± 2.7), median GOS was 4 (SD ± 1.3) while median GOS at 1 month was found to be 5 (SD ± 1.7). Similarly 31 (64.6%) patients were found to have a favourable outcome (GOS = 4, 5) while 17 (35.4%) patients were in the unfavourable outcome group (GOS = 1, 2, 3) **(Figure 1).** A total of 18 (37.5%) patients were lost to follow up at the end of 1 month **(Table 1).**

The clinical features of brain abscess patients included headache (n = 38, % = 79.2%), vomiting (n = 34, % = 70.8), fever (n = 26, % = 54.2) and fits (n = 14, % = 29.2). There were 20 (41.7%) patients who presented with focal deficits while 16 (33.3%) patients had papilledema **(Table 2).**

Etiology

The most common predisposing condition was chronic suppurative otitis media (CSOM) (n = 22, 45.8%), followed by congenital heart diseases (n = 9, 18.8%), meningitis (n = 4, 8.3%), postoperative (n = 2, 4.2%), VP shunt (n = 2, 4.2%) and trauma (n = 1, 2.1%). In 8 (16.7%) patients a predisposing condition was not found **(Table 2).**

Site

There were 18 (37.5%) abscesses located in the parietal lobes, followed by frontal (n = 8, 16.7%), occipital (n = 8, 16.7%), temporal (n = 7, 14.6%) and cerebellar (n = 7, 14.6%).

Pathogens

There were 26 (54.2%) cases where the bacterial culture yielded no growth while the most common

Table 1:

Variable	Mean	Median	Standard Deviation	P value
Age	9.7 years	10 years	± 4.5 years	
Duration of symptoms	15.1 days	14 days	± 6.5 days	
GCS on Admission	11.1	12	± 3.1	< 0.001
Abscess diameter	4.8 cm	5.0 cm	± 1.3 cm	< 0.32
Length of stay	6.6 days	6.0 days	± 2.7 days	
GOS at Discharge	3.5	4.0	± 1.2	
GOS at 1 Month	4.0	5.0	± 1.7	

aspiration of the abscess on first operation, 13 (27.1%) patients showed at least some degree of recollection as was found on radiologic imaging. Among those with recollections 10 (20.8%) patients underwent a repeat aspiration due to increasing collection within the abscess cavity. In bigger size drainage tube No. 8 was placed in 20 (41.7%) cases, while in 28 (58.3%) patients no tube was inserted. Among those with drainage tube insertion, only 2 (4.2%) cases were found to have presented with recollection or recurrence, while 11 (22.9%) patients were found with

Table 2:

Variable	Frequency (n)	Percent (%)	P value
Gender			0.19
Male	33	68.8	
Female	15	31.3	
Clinical Features			
Headache	38	79.2	0.001
Vomiting	34	70.8	0.52
Fever	26	54.2	< 0.001
Fits	22	45.8	< 0.001
Papilloedema	16	33.3	0.001
Focal deficits	20	41.7	0.95
Abscess Location			0.75
Parietal	18	37.5	
Frontal	8	16.7	
Occipital	8	16.7	
Temporal	7	14.6	
Cerebellum	7	14.6	
Predisposition			0.07
CSOM	22	45.8	
CHD	9	18.8	
Cryptogenic	8	16.7	
Meningitis	4	8.3	
Iatrogenic	2	4.2	
VP shunt	2	4.2	
Trauma	1	2.1	
Microorganism			0.16
E. Coli	8	16.7	
Streptococci	5	10.4	
MRSA	5	10.4	
Pneumococci	2	4.2	
Pseudomonas	1	2.1	
Listeria	1	2.1	
No Growth / Unknown	26	54.2	
Drain tube used			0.02
Yes	20	41.7	
No	28	58.3	
Recurrence	13	27.1	0.02
Drain used	2	4.7	
Drain not used	11	22.9	
Readmission	8	16.7	
Complications			
Recollection	17	35.4	
Ventriculitis	4	8.3	
CSF leak	2	4.2	
Septicaemia	1	2.1	
None	24	50	
GOS Groups			
Favourable	31	64.6	
Unfavourable	17	35.4	
Mortality			
Dead	7	14.6	
Alive	41	85.4	

recurrence among those without tube drainage **(Figure 2).** The mortality in this series was found to be 14.6% (7 patients) **(Table 2).**

Excision

Eight (8) out of the 48 patients ultimately required craniotomy and excision of abscess when initial aspirations were failed. Similarly 8 (16.7%) patients required readmission either for complication management or reoperation **(Figure 4).**

Statistical Analysis

The Pearson Chi-Square test showed that the presence of high grade fever and papilloedema were significantly associated with unfavourable outcome in terms of GOS ($p < 0.001$) while headache, vomiting, fits and focal neurologic deficits did not show any significant association. Similarly the use of in-situ drainage tube was significantly associated to lower recurrence and hence lower reoperation rates ($p = 0.024$) (OR = 0.17 (0.033 – 0.89), 95% CI) **(Figure 2).** Recurrence how-

ever, was not shown to be significantly associated with unfavourable outcome (p = 0.68). A GCS below 12 on admission was found to be significantly associated with poor outcome both in terms of unfavourable GOS (p < 0.001) as well as higher probability of death (p < 0.02) **(Figure 1).** The Pearson's correlation coefficient between admission GCS and GOS at discharge was r^2 =0.87 while it was -0.67 between admission GCS and mortality. Admission GCS was also strongly correlated to overall GOS at 1 month after surgery (r^2 = 0.71, p < 0.001). Similarly, multiple abscesses were related to an overall lower GCS at presentation (r^2 = 0.49) and an unfavourable GOS at discharge (r^2 = 0.46) **(Table 2).**

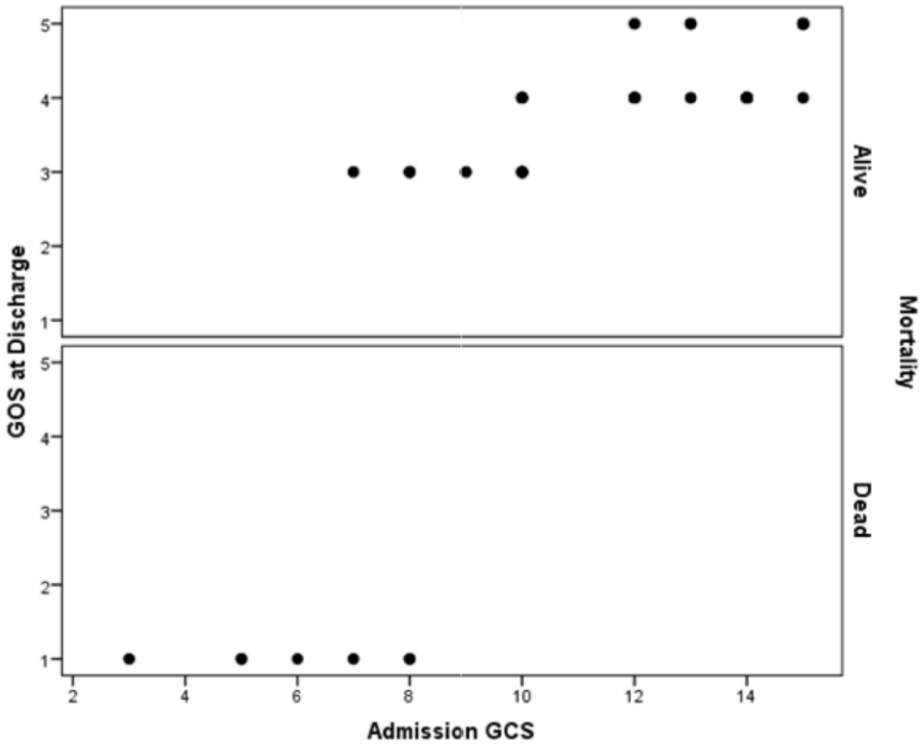

Figure 1: *Scatter plot for Admission GCS, GOS at discharge and Mortality.*

DISCUSSION

Brain abscess is a fatal disease with immense neurological consequences. The overall burden of pyogenic infectious diseases is still heavy in the developing societies despite the relative accessibility of diagnostic and therapeutic modalities. Similarly, the developed nations are witnessing increasing incidence rates for cerebral abscess patients due to high prevalence of patients with immunosuppressive conditions like human immunodeficiency virus infection and transplant recipients. The high incidence of upper respiratory tract infections like CSOM, mastoiditis and sinusitis especially in the younger age groups of the developing countries is the leading cause of intracranial complications such as meningitis, abscess and empyema. Poor socioeconomic conditions, poor hygiene and bad sanitary conditions of communities are the leading culprits for the endemic nature of these conditions.[7,11-13]

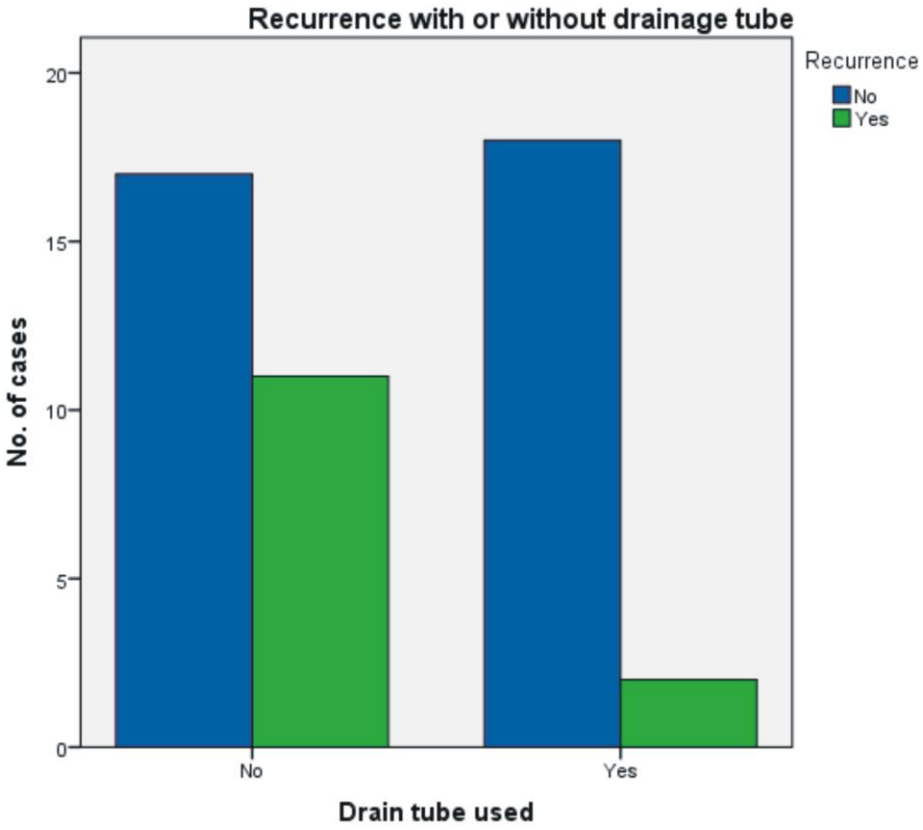

Figure 2: *Recurrence with or without tube drainage.*

The findings of our study were

Figure 3:
Abscess with a VP shunt in-situ (a rare complication).

in large similar to the findings of other studies, despite some variability in frequencies of different clinical features. Clinical studies by Shachor – Meyouhas et al,[14] Auvi-chayapat et al[15] and Goodkin et al,[16] on cerebral abscess in children has shown similar results, where mean age was 8 ± 2 years, male to female ratio of 2:1 to 3:1, and a high incidence of convulsions with headaches, fever, neurological signs convulsions, (41%, 81%, 78% and 41% respectively). These studies have also found CHD as the most common cause while otitis media was less common.[14-16]

Radoi et al findings were also similar to our study with the most common symptom as headache (80.76%), followed by vomiting (34.6%), focal deficits (42.3%), seizures (15.38%), fever (51.9%) and papilloedema (19.2%). The same study has also shown similar findings in relation to the predisposing conditions namely CSOM and sinusitis (23.07%), CHDs (26.9%), post-cranial surgery (5.7%) and trauma (5.7%) while 38.4% of cases presented with no known predisposing conditions while in our study there were no patients with unknown predisposition.[17] Additionally VP shunt infection was associated with two cases of cerebral abscess in our series **(Figure 3).**

Although gram positive cocci are frequently responsible for development of brain abscess in majority of cases, in the present study however, E. coli was found to represent the most common infectious agent, followed by streptococci, staphylococci, pneumococci, pseudomonas and listeria. These findings are similar to the bacteriological findings of large studies by Hsiao et al, and Mace et al.[18,19] Mehnaz et al,[4] has shown the causative pathogens specifically within the population of children with CHDs and also in relation to the occurrence of meningitis and septicaemia. E. Coli and streptococcus was found in majority of abscesses cultured from these patients.[4,12] However, in our study 54.2% (26) cases revealed no bacterial growth on pus culture, probably due to the fact that most patients were receiving intravenous antibiotics many days or weeks before surgery.[2]

Figure 4: *Right Parietotemporal brain abscess (CT Brain with contrast).*

GCS at presentation was found to be significantly associated ($p < 0.001$) to functional outcome both in long term and short term follow-up **(Figure 1).** This

finding concurred with the findings of Radoi et al, who compared admission GCS and outcome in terms of GOS ($p < 0.08$).[17] However, Zhang et al, found no association between admission GCS and outcome while stating that the poor correlation might be due to high percentage of patients who were immunocompromised or had pre-existing fatal disease.[2] Despite these findings by Zhang et al, there is adequate evidence that GCS is one of the most important factors determining functional outcome.

Out of the 48 patients included in this study, outcome was favourable at discharge in 64.6% of the subjects. The outcome was primarily related to the overall state of consciousness, number of the lesions, presence of septicaemia (as indicated by fever, hypotension and tachycardia), rapid recollection with midline shift and no or poor response to antibacterial therapy. The mortality rate in our study was 14.6% (7 cases). These findings are concurred by Zhang et al, Qureshi et al, Hsiao et al, while Atiq M et al, additionally reported significant correlation for midline shift on CT brain, cerebral oedema and seizures to poor outcome or increased mortality.[2,7,18,12]

All patients in our study were initially treated with burr-hole aspiration, as is proven by various studies for its effectiveness, rapidity, economy, less invasive nature, and lower rate of neurologic deficit. As Sarmast et al, described, after aspiration the reoperation rate was high (24%) while for the excision group there were no recorded repeat procedures, although there was a shorter LOS for the craniotomy and excision group.[20] After initially undergoing burr-hole aspiration, 27.1% of patients in our study developed recurrence or recollection of abscess. We adopted the use of a size 8 drainage tube inserted at the time of initial aspiration and re-aspirated at 24 hours interval until there was no aspirate obtained. This technique was shown to result in significantly lower recurrence and reoperation rates. Similar technique has been shown by Aurangzeb et al, to lower recurrence rates and consequently the lesser need for reoperation.[21] These authors have recommended the use of a drainage tube in high surgical risk patients (ASA III and IV classes). It has been shown that the use of a drainage tube for respiration at 24 hours interval significantly lowers recurrence rates (8.7%).[21] In our study there were only 2 (4.7%) cases which required reoperation in the form of excision while 22.9% without tube insertion required reoperation. 16.7% of patients ultimately required craniotomy and excision of the abscess capsule while 16.7% required readmission for complication management.

The commonest complications included failure to resolution despite surgical intervention (22.9%), ventriculitis (8.3%), CSF leak after craniotomy and excision (4.2%) and septicaemia (2.1%). The mean LOS for our study was 6.6 days (SD = 2.7) which is in contrast to the series of Sarmast et al, who has noted a mean LOS of 18.1 to 24.9 days.[20,23]

The mortality rate shown here (14.6%) is similar to the rates observed by other authors, which range between 8% and 53%.[2,21,22] Radoi et al, reported that the most important factors influencing mortality was the neurologic condition (GCS) of the patient at the time of admission.[17] Our study also revealed that GCS on admission was a critical factor influencing outcome and mortality **(Figure 1).**

CONCLUSION

Brain abscess is serious illness with grave consequences for the patient, both in terms of disability, death and financially. The paediatric population is at special risk of acquiring this disease due to the high preva-0lence of upper respiratory tract infections, congenital heart diseases in this population and due to their weak defence mechanisms lower systemic reserves. The high variability and non-specific nature of its clinical nature warrants the use of high suspicion in these patients. Repeat studies with larger sample size and controlled designs are required to establish the effectiveness of in-situ drainage tubes in terms of shorter LOS and lower recurrence.

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