

Original Article

Surgical Outcome of Brain Abscess after Single Burrhole Aspiration Technique in Terms of Glasgow Outcome Scale

Alamgir Khan¹, Fayyaz Ahmad², Ehsan-ur-Rehman³

¹Department of Neurosurgery, Pakistan Air Force (PAF) Hospital, ³Pakistan Institute of Medical Sciences (PIMS) Hospital, ²Hayatabad Medical Complex (HMC), Peshawar – Pakistan

ABSTRACT

Objectives: This case-series was aimed to determine the surgical outcome of brain abscess after a single burr hole aspiration technique in terms of the Glasgow outcome scale (GOS).

Material & Methods: The 100 cases were taken in the study with brain abscess. The favourable outcome included those patients with postoperative GOS of 4 or 5, at discharge and one month postoperatively whereas unfavourable outcome included patients with postoperative GOS of less than 4, at discharge and one month postoperatively.

Results: Of the 100 patients included, there were 72 (72%) males and 28 (28%) females. The overall mean diameter of the abscess was 6.01 cm \pm 1.90. Mean GOS was 2.95 \pm 0.86 while mean GOS 3.79 \pm 1.18. In this study 75% (n=75) patients presented with a GCS of 12 or less. Among these patients, 2 patients presented with a GCS of 5, 6 patients with a GCS of 7, 9 with GCS 8, 11 with GCS 9, 18 with GCS 10, 15 with GCS 11 and 14 patients presented with a GCS of 12. A favourable outcome was observed in 73 (73%) patients (GOS = 4 and 5), while 27 (27%) were in the unfavourable outcome group.

Conclusion: Although most of the patients present with a good neurological state, those who present with lower GCS are particularly prone to the poor postoperative outcome and higher mortality. The size of the brain abscess is also an important predictor of the postoperative outcome. The overall outcome for brain abscess aspiration was good.

Keywords: Brain abscess, Surgical Outcome, Burrhole Aspiration, Glasgow outcome scale (GOS).

Abbreviations: CSOM: Chronic Otitis Media. CHD: Congenital Heart Diseases. CT Scan: Computed Tomography Scan. GCS: Glasgow Coma Score. GOS: Glasgow outcome scale.

Corresponding Author: Alamgir Khan
Department of Neurosurgery, Pakistan Institute of Medical Sciences (PIMS) Hospital, Islamabad – Pakistan
Email: dr.alamgir Khan4u@yahoo.com

Date of Acceptance: 10-09-2021
Date of Online Publishing: 30-09-2021
Date of Print: 30-09-2021

Date of Submission: 15-07-2021
Date of Revision: 31-08-2021

DOI: 10.36552/pjns.v25i3.586

INTRODUCTION

We call brain abscess when an intracranial infection progresses from localised cerebritis to a late-stage abscess encased in a vascular capsule. The incidence rate is reported to range between 0.3 and 1.3 cases per 100,000 individuals per year in the United States, whereas it accounts for 8% of all cerebral mass lesions in impoverished countries. The male to female ratio is estimated to be in the range of 2:1 to 3:1, with 20 to 30-year-olds being the most often afflicted age group.¹⁻² More than a quarter of all brain abscess cases occur in children and adolescents, with the majority of cases coming from diseases such as chronic otitis media (CSOM), congenital heart diseases (CHD), trauma, and, in rare occasions, surgery.¹ Male to female ratios are projected to be in the 2:1 to 3:1 range, with those in their 20s and 30s being the most affected.¹⁻² Paediatric and adolescent brain abscesses account for about a quarter of all brain abscess cases. Chronic otitis media, congenital heart problems (CHD), trauma, and other factors are responsible for the majority of occurrences.³⁻⁶

Early cerebritis (1 – 4 days), late cerebritis (4 – 10 days), early capsule formation (11 – 14 days), and late capsule formation (> 14 days) are the four phases of brain abscess development.⁷ The clinical signs and symptoms of a brain abscess are non-specific and vary greatly. Headache, vomiting, loss of consciousness, and focal neurologic impairments are the most often reported symptoms.⁵ The typical trio of fever, headache, and leucocytosis, on the other hand, is commonly reported to be missing. Magnetic resonance imaging is the preferred method of diagnostic and preoperative planning.

Computed tomography scan with and without contrast is another common radiological investigation with high sensitivity and specificity.⁸⁻⁹ Antibiotics are used to treat bacterial brain abscesses, as well as surgical aspiration or excision. Usually, 6 to 8 weeks of high dose antibiotics are used for best results with biweekly

CT scan follow-up, followed by 2 to 3 months of oral antibiotics.⁹ Abscesses larger than 2.5 cm in diameter should be removed or drained, according to current clinical standards. The most frequent surgical approach is to aspirate the abscess with or without radiologic guidance using a brain cannula. However, there are growing worries about rising recall rates and the necessity for recurrent treatments. Aspiration, on the other hand, is preferable due to its less invasive nature, shorter operation length, success in collecting material for microbiological investigation, and relative efficacy in terms of reduced neurologic impairment after surgery. A randomised controlled trial comparing open excision versus aspiration and the absolute effectiveness of either method is lacking.^{1,9,10}

To reduce the rates of memory and recurrence of the subsequent aspiration, many methods have been tried. The use of drainage tubes inside the abscess cavity and regular draining of the collection is one of them, and it has shown promising results in terms of shorter hospital stays, lower mortality, and shorter hospital stays.¹¹ In a case series of brain abscess patients treated by burrhole aspiration. Sarmast et al. found that 85% of patients had a favourable result with 6% dying during therapy.¹² The current study was focused to determine the surgical outcome of brain abscess after a single burr hole aspiration technique in terms of the Glasgow outcome scale. The goal of this study was to see if a single burrhole aspiration can be used to treat all instances of brain abscess. The result will be graded on the Glasgow outcome scale and categorised as favourable or unfavourable. This will aid in the development of a solid evidence foundation for the treatment of brain abscesses.

MATERIAL & METHODS

Study Design & Setting

This was a case series descriptive study conducted in the Department of Neurosurgery, Hayatabad

Medical Complex (HMC), Peshawar from 22nd June 2015 to 21st December 2015. Prior ethical approval from the institute before conducting the study.

Sampling

Non-probability consecutive sampling method was used. The sample size was 100 using 85% favourable outcome of brain abscess¹², 95% confidence level and 7% margin of error with WHO software. A total of 100 patients were included in this study who fulfilled inclusion and exclusion criteria.

Inclusion Criteria

We included both male and female patients between 18 years to 60 years of age, who presented with the diagnosis of brain abscess within one week. We also included those patients who were with a single brain abscess of diameter more than 2.5 centimetres.

Exclusion Criteria

We excluded cases with other forms of intracranial pus collection such as subdural empyema, fungal abscess or tuberculous brain abscess. Patients excluded who were operated on elsewhere for brain abscess. The patients who were treated with more than one burrhole technique or with open excision were excluded. Those patients were excluded who were found with conservatively managed small brain abscesses. Moreover, patients with other co-morbidities which could affect the outcome were also excluded.

Assessment of Favourable Outcome

Brain abscess is termed as a focal collection of pus inside the brain parenchyma surrounded by a well-vascularized capsule which gives smooth ring-like contrast enhancement on CT scan of the

brain. The favourable outcome included those patients with postoperative Glasgow outcome score of 4 or 5, at discharge and one month postoperatively whereas unfavourable outcome included patients with Postoperative Glasgow outcome score of less than 4, at discharge and one month postoperatively.

Data Collection

The research only included patients who met the requirements for participation. Informed consent was taken from all patients of their attendance for data collection. A pre-designed proforma was used to collect data. This proforma contained information on the patient identity, such as name, age, gender, residence, admission number, Glasgow coma score (GCS) at presentation, abscess location, size, and result as measured by the Glasgow outcome scale.

Clinical Management

The clinical examination was supplemented with a CT scan of the brain with contrast or an MRI of the brain to confirm the diagnosis of a brain abscess. An expert Neurosurgeon decided on operative/conservative therapy. Patients who required surgery were operated on under general anaesthetic by an expert Neurosurgeon. Patients were monitored for one month following surgery until they were discharged from the hospital. Before discharge and one month following the surgery, a CT scan of the brain was also conducted. At the discharge, and one month after the surgery, the patients were evaluated by the expert for the outcome evaluation using the Glasgow outcome scale. Favourable outcome was marked for the patients with postoperative Glasgow outcome score of 4 or 5, at discharge and one month postoperatively. Unfavourable outcome was marked for the patients with Postoperative Glasgow outcome score of less than 4, at discharge and one month postoperatively.

Data Analysis

The data was analysed and assessed in SPSS version 25. Chi-square test and unpaired t-test were applied wherever required. A p-value of less than 0.050 was considered significant. Descriptive statistics like mean and standard deviations were calculated for quantitative variables like age, size of the abscess and GCS at presentation. Frequency/percentage were calculated for categorical variables like gender, location of the abscess and outcome (favourable or unfavourable). Outcome was stratified among age, gender, size of abscess and location of abscess.

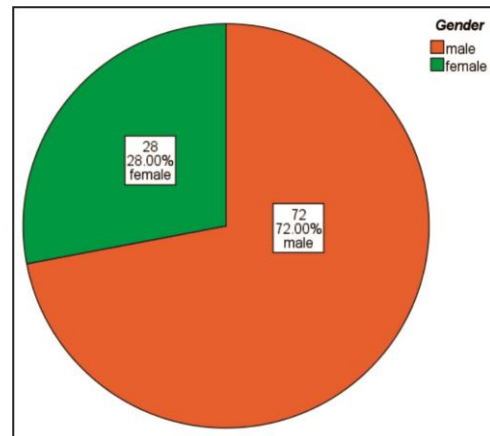


Figure 1: Gender distribution.

RESULTS

Gender Distribution

Of the 100 patients included, there were 72 (72%) males and 28 (28%) females in a ratio of 2.57 to 1.

Age Distribution

The overall mean age was 24.71 ± 7.52 years (range: 18-51 years). The age range was divided into two major categories, i.e., age range of 18-40 years as age group 1, while age range of 41-60 years was labelled as group 2 (See **Table 1**).

Figure 1 shows the gender distribution of the study sample.

Table 1: Age groups distribution of the study population.

Age groups	Frequency (n)	Percent (%)
18 – 40 years (Group 1)	95	95.0%
41 – 60 years (Group 2)	5	5.0%
Total	100	100.0%

Comparison of Clinical Variables in Groups

Table 2 shows the two groups to indicate the distribution of patients age, GCS (arrival) and diameter (cm) as favourable or unfavourable outcomes. The unpaired t-test was applied between the mean values of the above-mentioned variables. The results of the t-test indicated that there existed a significant difference (p-value: < 0.0001) between outcome groups: favourable or unfavourable for GCS (arrival) and diameter of abscess (cm).

Mean Values of GCS and GOS (Overall)

Overall mean arrival GCS was 10.88 ± 2.41 . The overall mean diameter was $6.01 \text{ cm} \pm 1.90$. Mean GOS was 2.95 ± 0.86 on discharge, while mean GOS 3.79 ± 1.18 on one month, postoperatively.

Table 3 shows the mean age, mean GCS and

Table 2: Comparison of Clinical Variables in Outcome Groups.

Parameters	Outcome groups		p-value	unpaired t-test	df	95% CI
	Favourable (Mean Values)	Unfavourable (Mean Values)				
Patient Age (years)	24.73 ± 7.30	25.30 ± 7.57	0.5884	0.5420	198	-2.6439 to 1.5039
GCS at Arrival	11.47 ± 2.22	9.30 ± 2.19	< 0.0001*	8.4515	198	1.6637 to 2.6763
Diameter (cm)	5.60 ± 1.72	7.11 ± 1.96	< 0.0001*	5.7906	198	-2.0242 to -0.9958

* Highly significant

Table 3: Mean age, mean GCS and mean diameter across the two outcome group's ± standard deviation.

Clinical Variable	Outcome Group	n	Mean	Std. Deviation
Patient Age	Favourable	73	24.73	7.303
	Unfavourable	27	25.30	7.574
Arrival GCS	Favourable	73	11.47	2.224
	Unfavourable	27	9.30	2.198
Diameter in cm	Favourable	73	5.60	1.722
	Unfavourable	27	7.11	1.968

mean diameter across the two outcome groups.

Gender Distribution in the Outcome Groups

Table 4 shows the gender distribution across the two outcome groups. Chi-square analysis between the age groups and outcome did not show any significance of association ($p = 0.5, 0.9$ respectively). The association of gender to outcome in terms of final GOS was not found to be statistically significant by the Chi-square test ($p = 0.82$).

Table 4: Gender distribution of the study population across outcome groups and its statistical significance.

Gender		Outcome Group		Total	p value
		Favourable	Unfavourable		
Male	n	53	19	72	0.82
	%	53.0%	19.0%	72.0%	
Female	n	20	8	28	0.82
	%	20.0%	8.0%	28.0%	

There were 82% ($n = 59$) males in the unfavourable GOS range at the time of discharge and 53.6% ($n = 15$) female patients in this range of GOS. Similarly, 46.4% ($n = 13$) females had a GOS of 4 at the time of discharge while only 18.1% ($n = 13$) males had a GOS of 4. See **Tables 4 and 5**.

Table 5: Age groups stratified for the outcome groups with their Chi-square significance.

Age Groups		Outcome Group		p value	
		Favourable	Unfavourable		
18 – 40 Years	Yes	n	70	25	0.50
		%	70.0%	25.0%	
	No	n	3	2	
		%	3.0%	2.0%	
41 – 60 Years	Yes	n	3	1	0.92
		%	3.0%	1.0%	
	No	n	70	26	
		%	70.0%	26.0%	

Abscess Location and Outcomes

Chi-square analysis of the abscess location for two outcome groups was non-significant as shown in **Table 6**. This shows that intracranial location of the abscess did not affect final outcome in terms of GOS.

Arrival GCS (grouped) Distribution

In this study, 75% ($n = 75$) patients presented with a GCS of 12 or less. Among these patients, 2 patients presented with a GCS of 5, 6 patients with a GCS of 7, 9 with GCS 8, 11 with GCS 9, 18 with GCS 10, 15 with GCS 11 and 14 patients presented with a GCS of 12. Arrival GCS was grouped into three, Group 1 was GCS 3 – 8, Group 2 being GCS 9 – 13 and Group 3 was GCS 14 – 15. Chi-square analysis showed that patients who presented in Group 1 had increasingly high number of unfavourable outcomes ($p = 0.001$) while patients in Group 3 showed higher number of favourable outcome ($p = 0.003$). Group 2 of GCS at arrival, however, did not show a significance for final outcome ($p = 0.89$). See **Table 7** and also **Figure 2** for distribution of GCS at arrival in the two outcome groups.

Abscess Diameter Across the Two Outcome Groups

Similarly, 66% (n = 66) patients presented with an abscess diameter of 6 or less on CT brain.

The rest 34% of patients presented with larger abscesses ranging between 7 to 10 cm in diameter. Larger size brain abscess was associated with unfavourable outcome with a p value of 0.02. It has been shown that smaller size abscesses were associated with higher chances of favourable outcome.

There were 75.3% cases of favourable outcome in the less than 6 cm diameter group as compared to 40.7% within the unfavourable outcome group. Similarly, only 24.6% patients had favourable outcome in the 7 – 10 cm range of abscess diameter while 86.7% cases had unfavourable outcome in this larger abscess diameter group.

See **Table 8 and Figure 3 – 4**. The most common location was frontal in 34 (34%) patients, which was followed in frequency by occipital in 26 (26%) cases, temporal in 17 (17%) cases, parietal in 13 (13%) cases and 10 (10%) cases (See **Table 6**).

Table 6: Abscess location across the study outcome groups with its Chi-square significance.

Abscess Location	Outcome Group		p value
	Favourable n = 73	Unfavourable n = 27	
Frontal	Yes n = 23 % = 23.0%	11 11.0%	0.38
	No n = 50 % = 50.0%	16 16.0%	
Temporal	Yes n = 13 % = 13.0%	4 4.0%	0.72
	No n = 60 % = 60.0%	23 23.0%	
Parietal	Yes n = 8 % = 8.0%	5 5.0%	0.31
	No n = 65 % = 65.0%	22 22.0%	
Occipital	Yes n = 21 % = 21.0%	3 3.0%	0.06
	No n = 52 % = 52.0%	24 24.0%	
Cerebellum	Yes n = 8 % = 8.0%	0 0.0%	0.07
	No n = 65 % = 65.0%	27 27.0%	

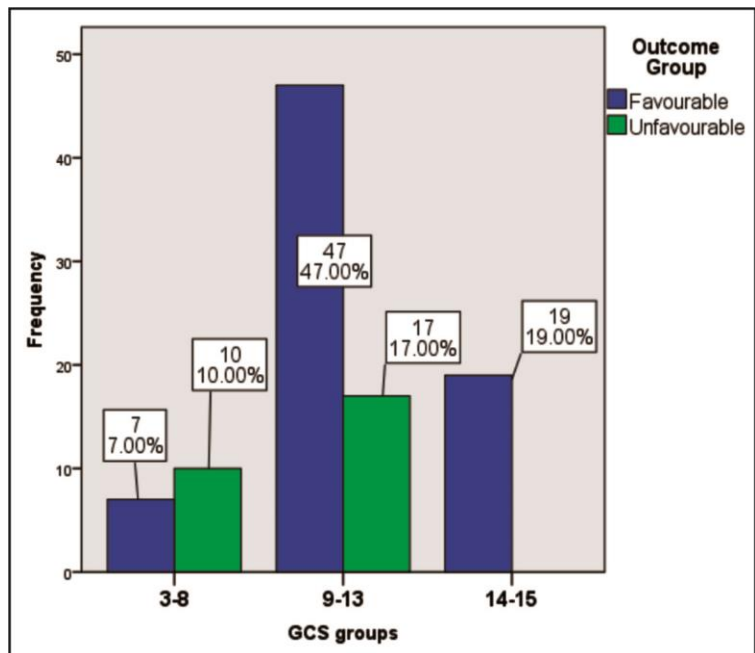


Figure 2: GCS on arrival across the two outcome groups.

Table 7: Arrival GCS (grouped) distribution across the two outcome groups and their statistical significance.

Arrival GCS (Grouped)			Outcome Group		p value
			Favourable	Unfavourable	
3 – 8	Yes	n	7	10	0.001 (significant)
		%	7.0%	10.0%	
	No	n	66	17	
		%	66.0%	17.0%	
9 – 13	Yes	n	47	17	0.89
		%	47.0%	17.0%	
	No	n	26	10	
		%	26.0%	10.0%	
14 – 15	Yes	n	19	0	0.003 (significant)
		%	19.0%	0.0%	
	No	n	54	27	
		%	54.0%	27.0%	

Table 8: Abscess diameter across the two outcome groups and its Chi-square significance.

Abscess Diameter			Outcome Group		p value
			Favourable	Unfavourable	
3 – 5 cm	Yes	n	44	6	0.001
		%	44.0%	6.0%	
	No	n	29	21	
		%	29.0%	21.0%	
> 5 cm	Yes	n	29	21	0.001
		%	29.0%	21.0%	
	No	n	44	6	
		%	44.0%	6.0%	

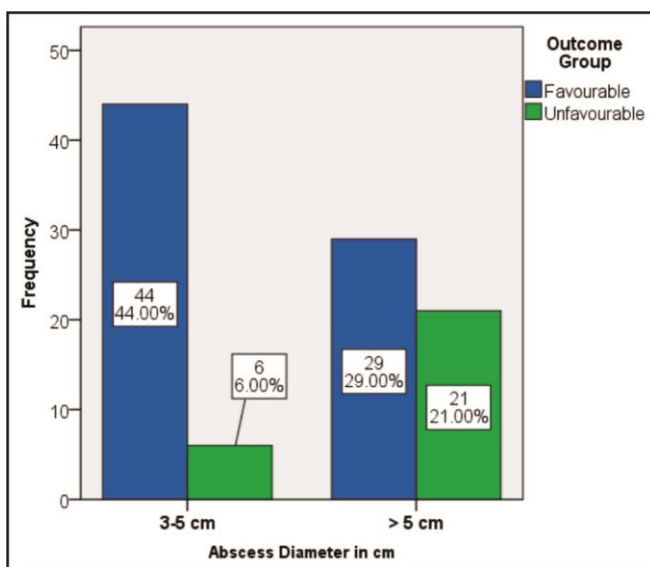


Figure 3: Abscess diameter across the two treatment groups.

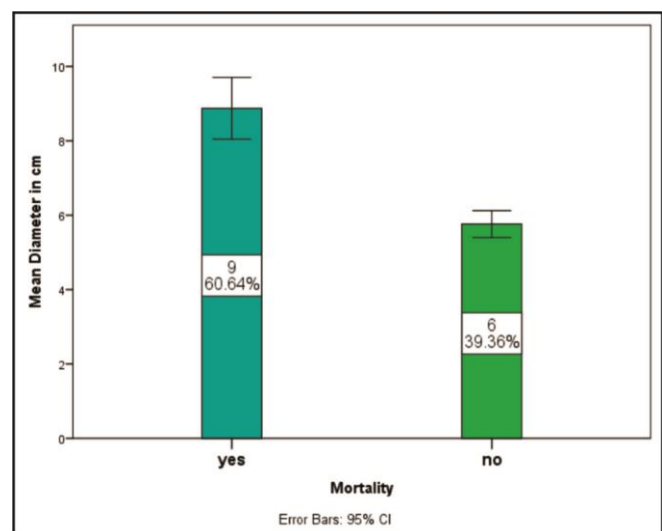


Figure 4: Mean abscess diameter and its impact on mortality.

GOS at One Month Follow-up

The GOS distribution at 1-month follow-up is shown in **Table 9**. Favourable outcome was observed in 73 (73%) patients (GOS = 4 and 5) while 27 (27%) were in the unfavourable outcome group. Among the unfavourable outcome group, 13 (13%) were in the severe disability group (GOS = 3), 7 (7%) were in the vegetative state (GOS = 2) while 8% (n=8) were dead (GOS = 1) at the end of follow-up period (see **Table 9**).

Table 9: GOS at 1 month follow up across the study population.

GOS	Frequency (n)	Percent (%)
1	8	8.0%
2	15	15.0%
3	51	51.0%
4	26	26.0%

DISCUSSION

Brain abscess is a serious condition with mortality of up to 60%. Despite advanced antibiotic therapies, the outcome remains chiefly surgical. In more than 97% of cases, the surgical intervention involves burrhole aspiration. Brain abscess is a serious infectious condition with serious sequelae in terms of prolonged or permanent disability and mortality.¹⁴ Pyogenic infections are on the rise all over the world, especially in developing countries like Pakistan despite increasing access to broad-spectrum antibiotics use and steadily increasing healthcare facilities. Immunosuppressive disorders such as AIDS, transplant and uncontrolled diabetes are one of the leading causes of brain abscess in adults.¹⁵ In the same way, respiratory infections such as chronic suppurative otitis media (CSOM), mastoiditis, and paranasal sinus infections are becoming more prevalent, leading to cerebral consequences like meningitis, abscess, and empyemas.^{15-16, 17}

Clinical investigations on cerebral abscess by Shachor-Meyouhas et al, Auvichayapat et al and

Goodkin et al. found comparable results, with a male to female ratio of 2:1 to 3:1, and a high frequency of convulsions with headaches, fever, neurological indications convulsions, and other symptoms (41%, 81%, 78% and 41%, respectively).¹⁹⁻²² Headache (80.76%) was the most prevalent symptom in Radio et al 22's study, followed by vomiting (34.6%), focal deficits (42.3%), seizures (15.38%), fever (51.9%), and papilloedema (19.2%). The same study found similar results in terms of predisposing conditions, such as CSOM and sinusitis (23.07%), CHDs (26.9%), post-cranial surgery (5.7%), and trauma (5.7%), while 38.4 percent of cases had no known predisposing conditions, whereas there were no patients with an unknown predisposition in our study.

In both long and short term follow up, GCS at presentation was shown to be substantially linked with functional outcome. This conclusion was consistent with Radio et al. findings, who compared admission GCS and GOS outcome.²³ Zhang et al.²⁴ found no link between admission GCS and outcome, claiming that the low connection might be attributed to the high number of immunocompromised patients or those with a pre-existing deadly illness. Despite Zhang et al findings, there is sufficient evidence that GCS is one of the most critical variables influencing the functional outcome. There was no difference in mean age between the two outcome groups in our study. Abdullah²³ discovered a significant connection between the arrival GCS and the postoperative GOS in prospective research. They did, however, discover a clear link between gender and patient age, with age more than 40 and female gender is strongly linked to an elevated risk of brain abscess and unfavourable outcomes. Out of the 100 patients who took part in this trial, 73% had a positive result upon discharge. The general level of awareness, the number of lesions, and the size of the lesion in cm all played a role in the result. In our investigation, the death rate was 8%.

Some studies also found a strong link between midline shift on CT brain, cerebral oedema, and seizures, as well as a poor result or increased mortality. All of the patients in our research were treated with burr-hole aspiration, which has been shown in several trials to be successful, quick, cost-efficient, less invasive, and has a reduced risk of neurologic impairment.^{15,24-29} According to Sarmast et al,²⁶ the reoperation rate following aspiration was significant (24%) whereas, there were no documented repeat operations in the excision group, despite the craniotomy and excision groups having a lower LOS. Aurangzeb et al²⁸ showed that placing an intralesional tube with the intermittent aspiration of the abscess at 24-hour intervals reduced recurrence rates and, as a result, the requirement for reoperation. The use of a drainage tube in patients with high surgical risk has been advocated by these authors (ASA III and IV classes). The use of a drainage tube for aspiration at 24 – hour intervals has been proven to dramatically reduce recurrence rates (8.7%). The death rate in this study is comparable to that reported by other researches.

CONCLUSION

Brain abscess is a fatal condition with increased incidence in younger age group patients. Although most of the patients present with a good neurological state, those who present with lower GCS are particularly prone to the poor postoperative outcome and higher mortality. The size of the brain abscess is also an important predictor of the postoperative outcome. The overall outcome for brain abscess aspiration is good. However, these findings suggest that brain abscess treatment should be aggressive and clinical vigilance be maintained to diagnose the condition early so that appropriate treatment can be initiated.

REFERENCES

1. Tunkel AR SW. Brain Abscess. In: HR W, editor. Youmans neurological surgery. 6th ed. Philadelphia: Elsevier, 2011: p. 588.
2. Zhang C HL, Wu X, Hu G, Ding X, Lu Y. A retrospective study on the aetiology, management, and outcome of brain abscess in an 11-year, a single-centre study from China. *BMC Infect Dis.* 2014; 14: 311.
3. Hussain A KA. Frequency of intracranial complications in chronic otitis media. *J Ayub Med Coll Abbottabad*, 2005; 17 (1): 75-7.
4. Khan A KM, Muhammad. Intracranial complications of chronic suppurative otitis media: clinical presentation and outcome of surgical procedures. *Gomal J Med Sci.* 2012; 10: 186-9.
5. Mehnaz A, Syed AU, Saleem AS, Khalid CN. Clinical features and outcome of cerebral abscess in congenital heart disease. *J Ayub Med Coll Abbottabad*, 2006; 18 (2): 21-4.
6. Qureshi H, Habib A, Siddiqui A, Mozaffar T, Sarwari A. Predictors of mortality in brain abscess. *J Pak Med Assoc.* 2002; 52 (3): 111-6.
7. Ersin E TC. Pyogenic brain abscess. *Neurosurg Focus*, 2008; 24 (E2): 1-10.
8. Rath TJ, Hughes M, Arabi M, Shah GV. Imaging of cerebritis, encephalitis, and brain abscess. *Neuroimaging Clin N Am.* 2012; 22 (4): 585-607.
9. D S. Management of brain abscesses. II: Antibiotics and computed tomography. *J Clin Neurosci.* 2013; 20 (12): 1675-81.
10. D S. Management of brain abscesses. I: Drainage and antiseptics. *J Clin Neurosci.* 2013; 20 (12): 1669-74.
11. LU CH, Chang WN, LIN YC, Tsai NW, Liliang PC, Su TM, et al. Bacterial brain abscess: microbiological features, epidemiological trends and therapeutic outcomes. *QJM.* 2002; 95 (8): 501-9.
12. Sarmast AH, Showkat HI, Kirmani AR, Bhat AR, Patloo AM, Ahmad SR, et al. Aspiration versus excision: a single center experience of forty-seven patients with brain abscess over 10 years. *Neurol Med Chir.* 2012; 52 (10): 724-30.
13. Aras Y, Sabanci PA, Izgi N, Boyali O, Ozturk O, Aydoseli A, et al. Surgery for Pyogenic Brain Abscess over 30 Years: Evaluation of the Roles of Aspiration and Craniotomy. *Turk Neurosurg.* 2016; 26 (1): 39-47.

14. Arora K, Dawkins RL, Bauer DF, Palmer CA, Hackney JR, Markert JM. Intracranial blastomycotic abscess mimicking malignant brain neoplasm: Successful treatment with voriconazole and surgery. *Surg Neurol Int.* 2015; 6: 174.
15. Atiq M, Ahmed US, Allana SS, Chishti KN. Brain abscess in children. *Indian J Pediatr.* 2006; 73 (5): 401-4.
16. Bajpai A, Prasad KN, Mishra P, Gupta RK, Singh AK, Ojha BK. Multimodal approach for diagnosis of bacterial etiology in brain abscess. *Magn Reson Imaging.* 2014; 32 (5): 491-6.
17. Ballantine HT, Jr., Shealy CN. The role of radical surgery in the treatment of abscess of the brain. *Surg Gynecol Obstet.* 1959; 109: 370-4.
18. Shachor-Meyouhas Y, Bar-Joseph G, Guilburd JN, Lorber A, Hadash A, Kassis I. Brain abscess in children - epidemiology, predisposing factors and management in the modern medicine era. *Acta Paediatr.* 2010; 99 (8): 1163-7.
19. Auvichayapat N, Auvichayapat P, Aungwarawong S. Brain abscess in infants and children: a retrospective study of 107 patients in northeast Thailand. *J Med Assoc Thai.* 2007; 90 (8): 1601-7.
20. Goodkin HP, Harper MB, Pomeroy SL. Intracerebral abscess in children: historical trends at Children's Hospital Boston. *Pediatrics.* 2004; 113 (6): 1765-70.
21. Clinical nuclear Medicine *Curr Treat Options Neurol.* Radoi M, Ciubotaru V, Tataranu L. Brain abscesses: clinical experience and outcome of 52 consecutive cases. *Chirurgia (Bucur).* 2013; 108 (2): 215-25.
22. Zhang C, Hu L, Wu X, Hu G, Ding X, Lu Y. A retrospective study on the aetiology, management, and outcome of brain abscess in an 11-year, single-centre study from China. *BMC Infect Dis.* 2014; 14: 311.
23. Abdullah J. Clinical presentation and outcome of brain abscess over the last 6 years in community based neurological service. *J Clin Neurosci.* 2001; 8 (1): 18-22.
24. Qureshi HU, Habib AA, Siddiqui AA, Mozaffar T, Sarwari AR. Predictors of mortality in brain abscess. *J Pak Med Assoc.* 2002; 52 (3): 111-6.
25. Hsiao SY, Chang WN, Lin WC, Tsai NW, Huang CR, Wang HC, et al. The experiences of non-operative treatment in patients with bacterial brain abscess. *Clin Microbiol Infect.* 2011; 17 (4): 615-20.
26. Sarmast AH SH, Kirmani AR, Bhat AR, Patloo AM, Ahmad SR. Aspiration vs excision: A single centre experience of forty-seven patients with brain abscess over 10 years. *Neurol Med Chir (Tokyo).* 2012; 52: 724-30.
27. Ratnaike TE, Das S, Gregson BA, Mendelow AD. A review of brain abscess surgical treatment--78 years: aspiration versus excision. *World Neurosurg.* 2011; 76 (5): 431-6.
28. Aurangzeb A, Khan SA, Ahmed E, Mehmood S, Ali A, Zadran KK, et al. Predisposing factors, clinical presentation and outcome of repeated aspiration in cerebral abscess through a drainage tube in situ. *J Ayub Med Coll Abbottabad.* 2011; 23 (4): 58-60.
29. Nathoo N, Nadvi SS, Narotam PK, van Dellen JR. Brain abscess: management and outcome analysis of a computed tomography era experience with 973 patients. *World Neurosurg.* 2011; 75 (5-6): 716-26; Discussion 612-7.

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	Intellectual Contribution to Paper in Terms of:
1.	Alamgir Khan	1. Study design and methodology.
2.	Fayyaz Ahmad	2. Paper writing, referencing, and data calculations.
3.	Ehsan-ur-Rehman	3. Data collection and calculations.
4.		4. Analysis of data and interpretation of results etc.
5.		5. Literature review and manuscript writing.
6.		6. Analysis of data and quality insurer.