Original Article

Clinical Profile and Surgical Outcomes of Brain Abscess with Emphasis on Otogenic Etiology: A Three-Year Tertiary Care Experience

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Abstract

Background: Brain abscess remains a significant cause of morbidity in developing countries, with otogenic infections and trauma as predominant etiologies. This study analyzes the clinical profile, microbiological spectrum, surgical outcomes, and predictors of mortality in patients with brain abscess from a tertiary care centre in North India. **Material and Methods:** This hospital-based retrospective observational study included 34 surgically managed patients with brain abscess over a three-year period. Demographic variables, clinical presentation, Glasgow Coma Scale (GCS) score at admission, etiological factors, radiological characteristics, microbiological findings, operative procedures, postoperative complications, and outcomes were analyzed. Survival analysis was performed using the Kaplan–Meier method. **Results:** The mean age was 19.8 ± 9.4 years, with 70.6% males and 64.7% of patients below 20 years of age. The most common presenting symptoms were fever (26.5%), headache (23.5%), and ear discharge (20.6%). At admission, 76.5% of patients had GCS 13–15. Otogenic infection was the predominant etiology (58.8%), followed by trauma (35.3%). Single abscesses were present in 70.6% of patients. Staphylococcus aureus was the most frequently isolated organism (41.2%). Craniotomy with excision was performed in 94.1% of patients. Postoperative complications included wound infection (29.4%), seizures (14.7%), and hydrocephalus (14.7%). Overall mortality was 8.8%, with a 30-day survival of 91.2%. On univariate analysis, multiple abscesses (p=0.04) and low admission GCS <9 (p=0.03) were significant predictors of mortality. **Conclusion:** Brain abscess in this region predominantly affects young males and is largely otogenic in origin. Multiplicity of lesions and poor neurological status at admission predict mortality. Early surgical intervention combined with appropriate antimicrobial therapy yields favorable short-term survival.

Keywords: Brain abscess, Otogenic infection, Staphylococcus aureus, Craniotomy, Glasgow Coma Scale, Mortality predictors.

Received: 22 April 2026 **Revised: 10 May 2026** **Accepted: 29 May 2026** **Published: 07 June 2026**

Introduction

A brain abscess is a focal intracerebral infection characterized by localized suppuration within brain parenchyma, resulting from contiguous spread (ear infection, dental abscess, paranasal sinusitis, mastoiditis), hematogenous dissemination from remote sources (lung, heart, kidney), or direct inoculation following head trauma or surgical procedures.[1] Brain abscess is frequently associated with congenital heart disease in children, particularly those with right-to-left shunts.[2]

In developing countries, chronic suppurative otitis media (CSOM) remains an important predisposing factor for intracranial suppurative complications. Otogenic brain abscess typically involves the temporal lobe and cerebellum due to anatomical proximity to the middle ear and mastoid air cells. Early recognition by primary care physicians and otolaryngologists is critical in preventing progression to life-threatening intracranial disease.

Despite advances in neuroimaging, antimicrobial therapy, and neurosurgical techniques, brain abscess continues to pose therapeutic challenges, particularly in low- and middle-income countries.[3] Regional differences in epidemiology, microbiological patterns, and healthcare access profoundly influence outcomes.[4] Brain abscesses account for approximately 8% of intracranial masses in low-resource countries compared to 1–2% in high-resource countries, with an incidence of about 4 cases per million population.[1]

In developed nations, improved antibiotic stewardship and early management of otogenic and sinus infections have substantially reduced incidence rates. Conversely, in developing regions, CSOM, trauma, and limited healthcare access remain major contributors.[5] The classic triad of fever, headache, and focal neurological deficits is present in only about 20% of patients, making early diagnosis challenging.[6]

Symptoms result from increased intracranial pressure (headache, vomiting, confusion), infection (fever), and focal

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DOI:
10.21276/amit.2026.v13.i2.720

How to cite this article: Narain N, Kansakar N, Singh AD, Chakraborty M, Thinles T, Dash S. Clinical Profile and Surgical Outcomes of Brain Abscess with Emphasis on Otogenic Etiology: A Three-Year Tertiary Care Experience. Acta Med Int. 2026;13(2):447-452.

neurological damage (hemiparesis, aphasia).[7] Common presenting features include headache (69–70%), mental status changes (65%), and focal deficits (50–65%).[1]

Mortality has declined from 40% in the pre-CT era to approximately 10% in contemporary series, with full recovery rates increasing from 33% to 70% over five decades.[6] Outcome depends on neurological status at presentation, abscess multiplicity, size, location, and timing of intervention.[8]

Identification of causative organisms is crucial for targeted antimicrobial therapy. A meta-analysis of 9,699 patients showed Streptococcus (34%) and Staphylococcus species (18%) as predominant pathogens.[6] Anaerobic and polymicrobial infections are increasingly recognized.[9] In immunocompromised patients, fungal etiologies must be considered.[10]

Recent literature emphasizes multidisciplinary management, early neuroimaging, and tailored surgical approaches ranging from stereotactic aspiration to craniotomy with excision.[11] However, regional data from North India remain limited. This study analyzes the clinical profile, etiological spectrum, microbiological characteristics, surgical outcomes, and predictors of mortality in a three-year retrospective study of brain abscess patients from a tertiary care hospital in North India.

Materials and Methods

This hospital-based retrospective observational study was conducted in the Departments of Surgery, Neurosurgery, and Otolaryngology (ENT) at a tertiary care center over a three-year period. A total of 34 patients diagnosed with brain abscess and managed surgically were included.

Patients of all ages were included if they had a confirmed diagnosis of brain abscess based on clinical presentation and contrast-enhanced computed tomography (CECT) findings, underwent surgical management (either craniotomy with excision or burr hole aspiration), and had complete clinical, radiological, and microbiological data available from medical records.

Patients were excluded if they had subdural empyema without parenchymal involvement, were managed conservatively without surgical intervention, or had incomplete medical records.

Data were collected from hospital records using a predesigned proforma and included demographic variables such as age and sex, clinical presentation including symptoms at onset and duration of illness, and neurological status assessed using the Glasgow Coma Scale (GCS) at admission. Etiological factors recorded included otogenic infection, trauma, congenital heart disease, and other identified sources.

Radiological characteristics documented from CECT reports included the number of abscesses (single versus multiple), size (categorized as <40 mm or >40 mm), location, presence of midline shift, and perilesional edema. Microbiological findings were obtained from pus culture and sensitivity reports. Operative procedures were recorded as either craniotomy with excision or burr hole aspiration. Postoperative complications noted included wound infection, seizures, hydrocephalus, hemiplegia, and hemiparesis. Outcomes assessed were in-hospital mortality and duration of hospital stay.

The diagnosis of brain abscess was established using contrast-enhanced computed tomography of the brain, which demonstrated characteristic ring-enhancing lesions with surrounding edema. The diagnosis was confirmed intraoperatively by the presence of pus within the abscess cavity as documented in operative notes.

All 34 patients underwent surgical intervention. The choice of procedure, either craniotomy with excision or burr hole aspiration, was determined by the neurosurgeon based on abscess characteristics including size, location, and multiplicity, as well as the patient's neurological status and overall clinical condition. Craniotomy with excision was the preferred approach for accessible solitary abscesses, while burr hole aspiration was reserved for critically ill patients with poor GCS who were unfit for major anesthetic intervention.

Pus samples obtained during surgery were sent to the microbiology laboratory for Gram staining, Ziehl-Neelsen staining (where indicated), and aerobic and anaerobic culture. Antibiotic sensitivity testing was performed using standard disk diffusion methods. These results were obtained from laboratory records.

All patients were followed until discharge, with follow-up information obtained from outpatient department records. For patients unable to attend follow-up, survival status was confirmed via telephone contact.

Data were compiled and analyzed using appropriate statistical methods. Categorical variables were expressed as frequencies and percentages, while continuous variables were expressed as mean ± standard deviation. Associations between categorical variables and mortality were assessed using Fisher's exact test, with a p-value of less than 0.05 considered statistically significant.

Survival analysis was performed using the Kaplan–Meier method to estimate 30-day in-hospital survival based on data from medical records. Patients were censored at the time of discharge if they were alive. The survival curve was constructed to illustrate the probability of survival over the follow-up period.

All statistical analyses were performed using SPSS version 27.0 (IBM Corp., Armonk, NY, USA).

Results

A total of 34 patients diagnosed with brain abscess were included in the study. The mean age of the cohort was 19.8 ± 9.4 years (range: 2 months to 50 years), with the majority of patients (64.7%) belonging to the age group below 20 years. The peak incidence was observed in the 11–20 years age group (52.9%). There was a marked male predominance, with 24 patients (70.6%) being male and 10 patients (29.4%) female, yielding a male-to-female ratio of 2.4:1 [Table 1].

The most common presenting symptoms were fever (26.5%), headache (23.5%), and ear discharge (20.6%). Vomiting and focal neurological deficits were each observed in 11.8% of patients, while seizures were reported in 5.9%. None of the

patients presented with the classical triad of fever, headache, and focal neurological deficit simultaneously. The average duration of symptoms before hospital presentation was 7 days [Table 2].

Table 1: Demographic Characteristics of the Study Population (n=34)

Variable	Frequency	Percentage (%)
Male	24	70.6
Female	10	29.4
Age distribution (years)		
0–10	4	11.8
11–20	18	52.9
21–30	7	20.6
31–40	2	5.9
41–50	3	8.8
Mean age (years)	19.8 ± 9.4	–

Table 2: Clinical Presentation and Neurological Status

Parameter	Number of Patients	Percentage (%)
Symptoms		
Fever	9	26.5
Headache	8	23.5
Ear discharge	7	20.6
Vomiting	4	11.8
Focal neurological deficits	4	11.8
Seizures	2	5.9
Admission GCS		
13–15	26	76.5
9–12	6	17.6
3–8	2	5.9

At admission, the majority of patients had relatively preserved neurological status, with 76.5% having a Glasgow Coma Scale (GCS) score between 13 and 15. Six patients (17.6%) had a GCS between 9 and 12, while only 2 patients (5.9%) presented with severe neurological compromise (GCS <9) [Table 2].

Otogenic infection (chronic suppurative otitis media) was identified as the most common source, occurring in 58.8% of patients. Traumatic causes, primarily road traffic accidents resulting in compound depressed skull fractures, accounted for 35.3% of cases. Congenital heart disease was the underlying etiology in 5.9% of patients [Table 3].

Table 3: Etiological Distribution

Etiology	Number of Patients	Percentage (%)
Otogenic	20	58.8
Traumatic	12	35.3
Congenital Heart Disease	2	5.9

Contrast-enhanced computed tomography revealed that 70.6% of patients had a single abscess cavity, while 29.4% had multiple abscesses. Lesion size was less than 40 mm in 55.9% of patients and greater than 40 mm in 44.1%. Midline shift and perilesional edema were each observed in 29.4% of patients. The most common lobe involved was the temporal lobe (35.3%), consistent with the predominant otogenic etiology, followed by the frontal lobe (20.6%) and temporoparietal region (17.6%).

Microbiological culture of abscess material demonstrated Staphylococcus aureus as the most frequently isolated organism, identified in 41.2% of patients. This was followed by Escherichia coli (17.6%), Proteus species (11.8%), and Streptococcus species (11.8%). Coagulase-negative Staphylococcus was identified in 5.9% of patients, while cultures were sterile in 5.9% [Table 4].

Table 4: Radiological and Microbiological Profile

Parameter	Number of Patients	Percentage (%)
Abscess type		
Single	24	70.6
Multiple	10	29.4
Lesion size		
<40 mm	19	55.9
>40 mm	15	44.1
Organism isolated		
Staphylococcus aureus	14	41.2
Escherichia coli	6	17.6
Proteus species	4	11.8

Streptococcus species	4	11.8
Coagulase-negative Staphylococcus	2	5.9
Sterile culture	2	5.9

Craniotomy with excision was the primary operative procedure, performed in 94.1% of patients. Burr hole aspiration was undertaken in only 2 patients (5.9%), both of whom presented with critically low GCS and were deemed unfit for major anesthesia. Both patients who underwent burr hole aspiration succumbed to their illness within 24 hours post-procedure.

Postoperative complications were observed in a significant proportion of patients. Wound infection was the most common complication, occurring in 29.4% of patients. Seizures and hydrocephalus were each observed in 14.7% of patients. Hemiplegia occurred in 11.8% and hemiparesis in 8.8% of patients.

The overall in-hospital mortality was 8.8% (3 out of 34 patients). Among patients with a single abscess, mortality was 4.2%, whereas among those with multiple abscesses, mortality was 20% (p = 0.04). Neurological status at admission showed a strong association with outcome: patients with GCS <9 had 50% mortality, compared to 16.7% for GCS 9–12 and 3.8% for GCS 13–15 (p = 0.03) [Table 5].

Table 5: Predictors of Mortality

Parameter	Alive	Dead	Mortality (%)	p-value
Abscess type				0.04
Single	23	1	4.2	
Multiple	8	2	20.0	
Admission GCS				0.03
3–8	1	1	50.0	
9–12	5	1	16.7	
13–15	25	1	3.8	

Kaplan–Meier survival analysis demonstrated an estimated 30-day survival probability of 91.2%. All mortality events occurred during the in-hospital period, with a stepwise decline in survival probability corresponding to the timing of deaths. Patients who survived to discharge remained alive at the end of the 30-day follow-up period.

Discussion

This study provides a comprehensive analysis of brain abscess in a tertiary care setting in North India, highlighting the demographic profile, etiological spectrum, microbiological characteristics, surgical outcomes, and predictors of mortality. The findings have important implications for clinical practice and public health policy in resource-limited settings. The mean age of 19.8 years and the predominance of patients below 20 years (64.7%) in this study contrast sharply with contemporary international data. A meta-analysis by Brouwer et al. reported a mean age of 34 years across 9,699 patients from 123 studies, with significant geographical variation.[6] Similarly, a Korean study by Park JS et al. reported a mean age of 66.3 years in their 10-year retrospective analysis, with 44% of patients aged over 65 years.[7] The younger age distribution in developing countries likely reflects the higher burden of pediatric chronic suppurative otitis media (CSOM), inadequate access to primary healthcare, and the prevalence of congenital heart disease in children.[2]

The male predominance observed in this study (male-to-female ratio 2.4:1) is consistent with global data and has been reported across different geographical regions. Brouwer et al. documented a male predominance of 2.4:1 in their meta-analysis,[6] while a Polish study by Furman-Dłubała et al. reported 61.9% males among 84 patients.[12] The reasons for this distribution are not entirely clear but may relate to increased exposure to risk factors such as trauma in males and possible gender-based differences in healthcare-seeking behavior.

Fever (26.5%), headache (23.5%), and ear discharge (20.6%) were the most common presenting symptoms in this series. Notably, none of the patients presented with the classic triad of fever, headache, and focal neurological deficits. This finding aligns with the meta-analysis by Brouwer et al., which demonstrated that the classic triad was present in only 20% of patients.[6] A Chinese study by Su et al. involving 65 patients reported headache in 64.6%, fever in 49.2%, and confusion in 27.3%.[10] The absence of classic symptoms in most patients underscores the need for a high index of suspicion, particularly in young patients with risk factors such as CSOM or recent head trauma.

The average duration of symptoms before hospital presentation was 7 days, reflecting delayed healthcare-seeking behavior. Similar delays have been reported in other studies, with Park JS et al. documenting a median symptom duration of 8 days in their Korean cohort.[7]

The majority of patients (76.5%) presented with preserved neurological status (GCS 13–15), which likely contributed to the relatively favorable overall mortality. The level of consciousness at presentation has consistently been shown to be the most powerful predictor of outcome in brain abscess. Park et al., in their study of 112 patients over two decades, found that poor neurological status (GCS <13) on admission independently predicted unfavourable clinical outcomes.[8] In the present study, patients with GCS <9 had a mortality of 50%, compared to only 3.8% in those with GCS 13–15, reaffirming the strong association between admission neurological status and outcome.

Otogenic infection was the predominant etiology, accounting for 58.8% of cases. This finding aligns with numerous studies from developing countries reporting CSOM as the leading source of brain abscess.[5] However, this contrasts sharply with recent series from developed countries. The Korean study by

Park JS et al. identified neurosurgical procedures (32%) as the most common predisposing factor, followed by hematogenous infections (24%).[7] Similarly, the Polish study by Furman-Dłubała et al. found odontogenic infection (50%) to be the most common source, followed by paranasal sinusitis (15.5%) and otogenic infection (10.7%).[12]

Trauma accounted for 35.3% of cases in the present study, reflecting the increasing burden of road traffic accidents in India and the frequent delay in definitive surgical management of compound depressed skull fractures. This proportion is substantially higher than in Western series, where trauma accounts for less than 10% of cases.[6]

Congenital heart disease (CHD) was identified in only 2 patients (5.9%), which likely underestimates the true contribution of CHD to brain abscess pathogenesis. In developed countries, CHD-associated abscesses have become rare due to early surgical correction of cardiac defects.[2]

The predominance of solitary abscesses (70.6%) and temporal lobe involvement (35.3%) in this series is consistent with the otogenic etiology. Multiple abscesses were present in 29.4% of patients and were associated with significantly higher mortality (20% vs. 4.2%, p=0.04). Recent studies have reported variable rates of multiple abscesses. The Chinese study by Su et al. found that 77.3% of patients had single abscesses, with frontal lobe (40.9%) being the most common location, followed by temporal lobe (11.4%).[10] The Korean study reported single abscesses in 80% of patients, with frontal lobe predominance (36%).[7]

Staphylococcus aureus was the most frequently isolated organism (41.2%), which contrasts with several recent studies reporting streptococci as the predominant pathogens. The meta-analysis by Brouwer et al. found that Streptococcus species accounted for 34% and Staphylococcus species for 18% of isolates.[6] The Korean study identified Gram-positive Staphylococcus as the most common pathogen, with Streptococcus species also frequently isolated.[7] The Chinese study reported Streptococcus species in 63.1% of patients, with viridans group streptococci predominating.[10]

The high prevalence of S. aureus in the present study may be explained by the significant proportion of trauma-related cases, where skin flora is the usual pathogen. Similar findings have been reported from other centers with high trauma rates.[5]

Craniotomy with excision was the preferred surgical approach (94.1%), reflecting the institutional preference for complete removal of the abscess capsule. Recent studies have shown comparable outcomes between aspiration and excision. Park JS et al. reported that among 17 surgically treated patients, 52.9% underwent stereotactic drainage and 47.1% underwent craniotomy with excision, with no significant difference in outcomes between the two techniques.[7] The Polish study reported that 57.1% of patients underwent surgery (stereotactic aspiration or excision), with the average abscess diameter in surgically treated patients being 31.8 mm compared to 21.4 mm in those treated conservatively.[12]

Wound infection was the most common postoperative complication (29.4%), highlighting the challenges of infection control in resource-limited settings. Seizures (14.7%) and hydrocephalus (14.7%) were the next most common complications. Postoperative seizure rates in the literature range from 14% to 71% depending on follow-up duration.[7]

The overall mortality of 8.8% in this series compares favorably with contemporary international data. The meta-analysis by Brouwer et al. documented a decline in case fatality rate from 40% to 10% over the past five decades.[6] Recent studies have reported mortality rates of 5.88% (Korean study),[7] 3.1% (Chinese study) [10], 6% (Polish study),[12] and 13% (Park et al.).[8] The 30-day survival probability of 91.2% in the present study is consistent with these contemporary outcomes.[Table 6]

Study (Year)	Country	Sample Size	Mean Age (years)	Male (%)	Mortality (%)	Predominant Organism
Brouwer et al. (meta-analysis),[6] (2014)	Multinational	9,699	34	71	10	Streptococcus (34%)
Su et al,[10] (2023)	China	65	50.7	75.4	3.1	Streptococcus (63.1%)
Park JS et al,[7] (2023)	Korea	25	66.3	64	5.9	Staphylococcus
Park JO et al,[8] (2025)	Korea	112	54*	80	13	Streptococcus (29%)
Furman-Dlubala et al,[12] (2025)	Poland	84	50.1	61.9	6	Streptococcus (15.5%)
Present Study (2025)	India	34	19.8	70.6	8.8	S. aureus (41.2%)

On univariate analysis, two factors emerged as significant predictors of mortality: multiple abscesses and low admission GCS (<9). Patients with multiple abscesses had a mortality of 20% compared to 4.2% in those with single abscesses (p=0.04). Similarly, patients presenting with GCS <9 had 50% mortality compared to 3.8% in those with GCS 13–15 (p=0.03). These findings are consistent with global evidence. The Korean study identified headache and confusion as independent predictors of poor outcome.[7] The Chinese study found confusion to be the only independent factor associated with poor outcome.[10] Park et al. confirmed that poor neurological status (GCS <13) on admission independently predicted unfavorable outcomes.[8]

An interesting finding from recent literature is the association between hyperglycemia and prolonged antibiotic therapy. Park et al. demonstrated that hyperglycemia at admission (≥140 mg/dL) was an independent predictor of the need for long-term antibiotic use, with blood glucose levels positively correlated with duration of antimicrobial therapy.[8]

Limitations:

- Small sample size (n=34) limits statistical power and generalizability
- Single-centre design may not reflect regional or national patterns
- Lack of long-term functional outcome assessment (follow-up limited to 30 days)
- Absence of stereotactic aspiration and advanced neuroimaging (MRI, diffusion-weighted imaging, MR spectroscopy)
- No systematic evaluation of antibiotic resistance patterns

- Potential selection bias due to exclusion of conservatively managed patients

Conclusion

This three-year study from a tertiary care center in North India demonstrates that brain abscess predominantly affects young males (mean age 19.8 years, 70.6% male), with otogenic infection (58.8%) as the leading cause and Staphylococcus aureus (41.2%) as the predominant organism. The classical clinical triad was absent in all patients, highlighting the need for heightened diagnostic suspicion. Surgical management with craniotomy and excision achieved favourable outcomes, with an overall mortality of 8.8% and 30-day survival of 91.2%. Multiple abscesses and low admission GCS (<9) were significant predictors of mortality on univariate analysis.

These findings underscore the importance of early diagnosis, prompt surgical intervention, and appropriate antimicrobial therapy in achieving outcomes comparable to international standards. Addressing preventable etiologies through improved primary healthcare, timely management of otogenic infections, and effective road safety measures remains essential to reduce the burden of brain abscess in resource-limited settings.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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