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ABSTRACT

Background: Brain abscess is a life-threatening intracranial infection, typically caused by contiguous spread (e.g., sinusitis) or hematogenous seeding (e.g., endocarditis), and is more common in males and in developing countries, with peak incidence in the first two decades of life. Symptoms include headache, fever, altered mental status, nausea/vomiting, seizures (25–34%), and focal neurological deficits. It progresses through four stages over 2–4 weeks, culminating in capsule formation. Diagnosis is best achieved with MRI (especially DWI and ¹H-MRS), which differentiates abscesses from tumors, while CT supports localization and monitoring. Treatment involves ≥6 weeks of BBB-penetrating antibiotics and surgery—stereotactic aspiration for abscesses >2.5 cm, or excision for complex cases. Corticosteroids are used cautiously; anticonvulsants may be continued long-term. With prompt combined therapy, cure rates exceed 90%. Close imaging follow-up is essential to detect complications. This study highlights significant variability in presentation, pathology, management, and outcomes among surgical patients.

Methods: This prospective study analyzed 17 patients with brain abscess treated surgically at the Department of Neurosurgery, SVP Hospital and SMT. NHL Medical College, Ahmedabad, between January 2022 and August 2025. Inclusion required microbiological/histopathological confirmation of infection, characteristic MRI/CT findings, and lesion resolution with antibiotics; cases due to postoperative complications or meningoencephalitis were excluded. All patients underwent baseline and serial CT scans to evaluate abscess size, wall morphology, and perifocal edema. Abscesses ≥2 cm were managed surgically—predominantly via craniotomy and excision—while those <2 cm received medical therapy alone. Empirical broad-spectrum intravenous antibiotics were initiated immediately, adjusted based on culture and sensitivity, and continued for six weeks. Adjunctive corticosteroids were given under antibiotic cover and tapered over four weeks. Postoperative CT was performed within 24 hours, followed by imaging at 1, 3, and 6 months. Clinical outcomes were assessed using the modified Rankin Scale. The study underscores a standardized, multimodal approach to brain abscess management with favorable outcomes.

Keywords

brain abscess, neurosurgery, bacterial, pyogenic, tuberculous, hydatid cyst, excision, aspiration, diagnosis, outcomes



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Results: This prospective study analyzed 17 brain abscess patients (8 males, 9 females; median age 29 years) treated at SVP Hospital, Ahmedabad (Jan 2022–Aug 2025). Most common symptoms were fever/meningeal signs (11), seizures (5), headache (5), and neurological deficits (6). Temporo-parietal location predominated (11 cases); mean abscess size was 4.5 cm. Sixteen underwent craniotomy with excision; one had aspiration. All received 6 weeks of IV antibiotics (adjusted per culture) and a 4-week steroid taper. Causative organisms were identified in 10 cases (*Staphylococcus* spp., *Streptococcus*, *M. tuberculosis*, *Aspergillus*, hydatid cyst); 6 were culture-negative. Complications included ventriculitis with hydrocephalus (1), managed with ventriculostomy ± VP shunt. At 6 months, 88.23% had good outcomes (mRS 0–2); 2 patients died (one with congenital heart disease and altered sensorium, the other from meningitis/encephalitis). No recurrences occurred. Early diagnosis, surgical excision, and prompt antimicrobial therapy significantly predicted favorable outcomes ($p < 0.001$).

Conclusion: CNS infections remain life-threatening, demanding urgent multimodal care. Pyogenic brain abscesses >2 cm require emergent surgery—usually burr-hole aspiration; craniotomy is reserved for complex cases. Prolonged (≥ 6 weeks) IV antibiotics prevent relapse. Despite challenges like diagnostic delays and antimicrobial resistance, outcomes have improved with advanced diagnostics, targeted therapy, and neurocritical care. Timely treatment yields excellent recovery. Reducing the global burden requires equitable access, innovation, and a holistic approach spanning prevention to rehabilitation.

INTRODUCTION

Brain abscess is a focal intraparenchymal infection characterized by an encapsulated collection of purulent material, immune cells, and other materials following bacterial or fungal infection. The incidence of brain abscesses is approximately 8% of intra-cranial masses in developing countries and 1–2% in the developed western countries. Brain abscess still continues to be a significant problem in the developing world due to poverty, illiteracy and lack of hygiene.[1] They begin as localized areas of cerebritis in the parenchyma and evolve into collections of pus enclosed by a well vascularized capsule. It is well known that the brain does not have an immune system of its own and an intact blood brain barrier is largely impervious to infections. It is exemplified by the fact that CNS infections are uncommon compared to a large proportion of patients inflicted with septicemia or pyemia. Brain abscess is one of the most serious diseases of the central nervous system. This condition is more common among men two to three times, and the morbidity rate is highest in the fourth decade of life. Most brain abscesses

occurred in the first two decades of life.[2] An abscess can primarily present in four basic syndromes viz. focal mass expansion, intra-cranial hypertension, diffuse destruction, focal neurological deficit. There are marked variations in clinical symptoms and signs. Headache, changes in level of consciousness, nausea and/or vomiting, and high fever are the most common complaints.[3] Seizure is occurring in 25–34% of patients.[4] Brain abscesses may be unicentric or multifocal. Majority, about 90% result from peri cranial infections like sinusitis, mastoiditis, otitis media and many who are hematogenous borne (those from bacterial endocarditis) are multifocal, especially from cyanotic congenital heart disease.

A pontine abscess may bulge posteriorly compressing the aqueduct of Sylvius causing obstructive hydrocephalus or an occipital abscess may rupture into ventricle causing ventriculitis or ependymitis or it may cause septic thrombophlebitis of the transverse sinus causing venous hypertension, edema, seizures and raised intra-cranial pressure. Brain abscess development can be divided into four stages: 1) early cerebritis (1–4 days); 2) late cerebritis (4–10 days); 3) early capsule formation (11–14 days); and 4) late capsule formation (>14 days). Development of a brain abscess requires inoculation of an organism into the brain parenchyma in an area of devitalized brain tissue or in a region with poor microcirculation, and the lesion evolves from an early cerebritis stage to the stage of organization and capsule formation.[5] CT facilitates early detection, exact localization, and accurate characterization, determination of number, size and staging of the abscess. It also detects hydrocephalus, associated infections like subdural empyema, ventriculitis and assessment of adequacy of treatment and sequential follow up.

MRI features recognize pyogenic abscesses fairly accurately. A central area of liquefaction gives high signals while the surrounding edematous brain tissue gives low signals on T1 weighted images. The maturity of the abscess is indicated by the rim, which is formed by the collagen and inflammation. Diffusion weighted imaging (DWI) usually shows restricted diffusion (bright signal) that helps to differentiate abscesses from necrotic neoplasms, which are not usually restricted. [6,7] Proton magnetic resonance spectroscopy (1H-MRS) can detect a choline resonance that is largely due to

glycerophosphocholine. 1H-MRS is a safe, non-invasive imaging modality and can accurately differentiate between necrotic/cystic tumor and cerebral abscesses.[8] At 3–4 weeks, the abscess capsule becomes thick and is amenable to excision.

There is minimal risk of perforation and the possibility of its complete separation from the brain parenchyma. Antibiotics help eradicate the infection and the abscess wall involutes itself. Initial therapy should be commenced with broad spectrum antibiotics which cross blood-brain and blood-CSF barriers in adequate concentrations. After the pus is drained and the antibiotic sensitivity reports become available, specific bactericidal agents for the organism cultured should be administered. If the culture is negative for organism, then the broad-spectrum antibiotics should be continued according to the likely predisposing cause (primary source) and the anatomic location of abscess.[9] Usually 'triple high dose' antibiotics intravenously for 2 weeks followed by four weeks of oral therapy is recommended. Metronidazole readily penetrates brain abscesses; intralesional concentrations have been found to be 40 mg/mL. Steroid administration should be generally avoided unless the patient demonstrates signs of meningitis or disproportionate cytotoxic edema posing a life-threatening problem. Legg advocated anticonvulsant therapy for 5 years to all patients with cerebral abscess.[10] Patients presenting with rapidly progressive neurological deficits due to the mass effect of the neuroradiologically diagnosed brain abscess are strict candidates for urgent decompression.[11]

Aspiration repeated as necessary or with drainage, has widely replaced attempts at complete excision. However, Excision is recommended for the multiloculated abscesses, posttraumatic abscesses containing foreign bodies or contaminated retained bone fragments, and abscesses due to fistulous communication. Several reports have advocated excision as the procedure of choice because it is often followed by a lower incidence of recurrence and shorter hospitalization.[12] Computed tomography (CT) guided stereotactic aspiration is particularly advocated in management of deep-seated abscesses, multiple abscesses, and abscesses located in eloquent areas of the brain. The technique of fiber tracking based on diffusion tensor imaging offers the unique possibility of localizing the white

matter pathways of the brain in vivo.[13] A combination of the surgical aspiration or removal of all abscesses larger than 2.5 cm in diameter, a six weeks or longer course of intravenous antibiotics, and weekly CT or MRI imaging should result in a cure rate of more than 90%. It is important to follow the patient carefully by CT or MR imaging until the abscess has completely resolved. If any abscess enlarges after two weeks of antibiotics or fails to resolve after three to four weeks of antibiotics, further surgical aspiration or excision should be performed.

Periventricular brain abscesses often require craniotomy given the risk of intraventricular rupture.[14] This study describes the differences in clinical manifestations, pathology, management and outcomes of patients treated with operative intervention.

METHODS

A prospective analysis of 17 cases of brain abscess treated at the Department of Neurosurgery, SVP Hospital and SMT. NHL Medical College, Ahmedabad is presented. 17 patients who underwent craniotomy with excision of brain abscess or aspiration between January 2022 and August 2025 were included according to inclusion criteria: evidence of infection in brain specimens obtained through surgical aspiration or lesion excision and brain magnetic resonance imaging and/or computed tomography findings of brain abscess and reversal of brain lesion with antibiotic therapy. Patients with brain abscess due to post op complications and meningioencephalitis were excluded.

The clinical and radiological records were retrieved with respect to age, sex, duration of symptoms, clinical presentation, laboratory tests, radiological imaging, abscess site, surgical therapy, microbiological information, clinical and radiological outcome. CT scan was performed in all patients as an initial and follow-up exam. The diameter of the abscess, abscess wall, perifocal edema was assessed on CT scan. Abscesses measuring less than 2 cm in mean diameter were treated by medical regimen. Surgery was performed for abscess greater than 2 cm. Empirical intravenous broad spectrum antibiotics were immediately instituted upon diagnosis and were further modified according to microbiological isolation and antibiotic sensitivity. Antibiotic therapy was continued for a total period of

6 weeks. Steroids were administered under antibiotic cover. They were gradually tapered over a period of 4 weeks. Most of the patients underwent excision of the abscess through Craniotomy. Follow-up CT imaging was performed within 24 hours of excision. Further CT imaging was advised at intervals of 1, 3 and 6 months. The surgical outcomes were assessed in all patients according to the modified Rankin score.

Statistical analysis

Frequencies or percentages of variables and means and standard deviations for continuous variables were used to present data. Data were presented as the frequency or percentage for categorical variables. The analysis was carried out using the SPSS 13 program for Windows.

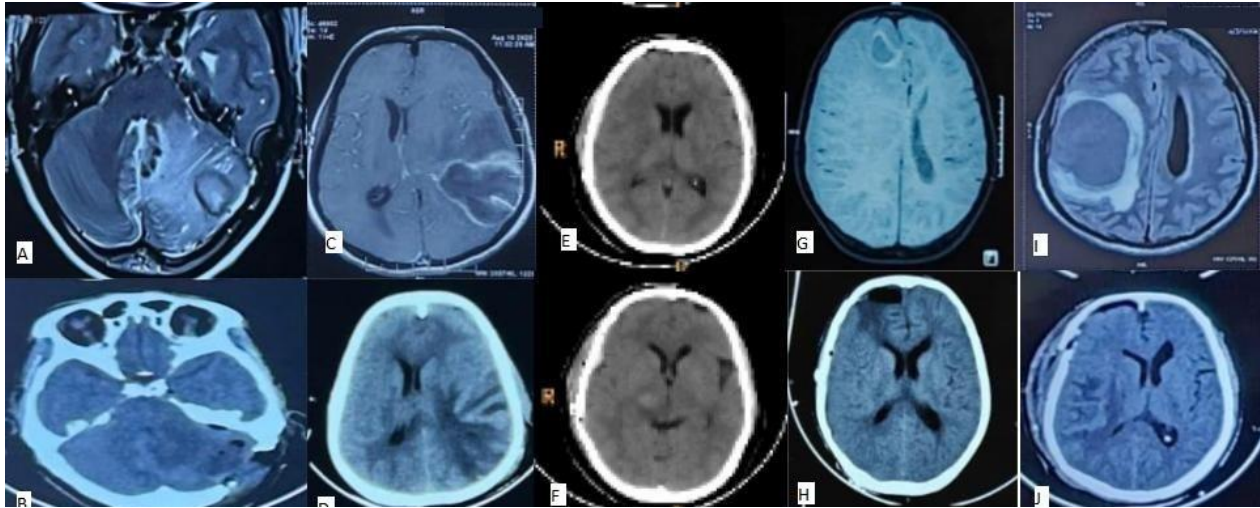


Figure 1. Pre- and postoperative radiological images: (A) preoperative MRI of the brain suggesting left cerebellar abscess after radical mastoidectomy; (B) postoperative CT of the brain of the same patient; (C) preoperative MRI of the brain suggesting left temporoparietal tuberculous abscess; (D) postoperative CT of the brain of the same patient; (E) preoperative CT of the brain suggesting right thalamic SOL in fungal infection; (F) postoperative CT of the brain of the same patient; (G) preoperative MRI suggesting right frontal abscess; (H) postoperative CT of the brain of the same patient; (I) preoperative MRI suggesting right temporo-parieto-occipital hydatid cyst; (J) postoperative CT of the brain of the same patient.

Table 1. Data of clinical features, radiological imaging, outcome and other parameters in the study population.

Sr No.	Age	Sex	Clinical presentation	Diagnosis	Radiological imaging	Pathogen	Treatment	Outcome (30 days)
1	83 year	F	Convulsion, fever	Right parasagittal frontal tuberculous	CT scan:- Ring enhancement in right frontal parasagittal region	M.Tuberculi	Craniotomy and Excision	NO Neurological deficits
2	1 month	F	Vomiting, fever	Cerebellar abscess	MRI:- hyper intensity in bilateral cerebellar region with hydrocephalus ? Medulloblastoma	No organism	Craniectomy and Excision	Full recovery
3	3 month	F	Convulsion, fever, vomiting	Left frontal abscess	MRI:- left frontal IPH	No organism	Craniotomy and Excision	Discharge with full recovery → meningitis with hydrocephalus → readmit → right vp shunt → expired
4	39 year	F	Neck pain, headache, giddiness, h/o left MRM	Left cerebellar abscess	MRI:- altered signal intensity in left cerebellum with mass effect	Streptococcus anginosus	Craniectomy and Excision with EVD	No neurological deficit
5	62 year	M	Convulsion	Left parietal abscess	MRI:- left parietal infarct	No organism	Craniectomy and Excision	Mild neurological deficit
6	29 year	F	Fever	Left cerebellar abscess	MRI:- altered signal intensity in left cerebellum	Staphylococcus	Craniotomy and Excision	No neurological deficit
7	1 month	F	Bulging in head	Left cerebral abscess with hydrocephalus	MRI:- altered signal intensity in 3rd ventricle and hydrocephalus	No organism	Right VP Shunt followed by craniotomy and excision	No neurological deficit
8	43 year	M	Fever, headache, right upper and lower limb weakness	Left parietal abscess	MRI:- left parietal hyper intensity without mass effect	Streptococcus anginosus	Craniectomy and Excision	No neurological deficit

Sr N o.	Age	Sex	Clinical presentation	Diagnosis	Radiological imaging	Pathogen	Treatment	Outcome (30 days)
9	33 year	M	Headache, fever, loss of hearing, abnormal speech, difficulty in vision; h/o pulmonary Koch	Left frontotemporal abscess	MRI:- altered signal intensity in left ftp region with mass effect	M.Tuberculi	Craniotomy and Excision	Mild neurological deficit
10	29 year	F	Fever, generalised weakness, altered sensorium; k/c/o congenital heart disease	Left cerebral abscess	MRI:- Ring enhancement in Left parietotemporal	No organism	Ventriculostomy	Expired due to cardiac co morbidity
11	17 year	F	Fever	Right ftp and sellar abscess	MRI:- Ring enhancement in right ftp and sellar region With edema	Staphylococcus	Craniectomy and Excision	Mild neurological deficit
12	39 year	M	Left parietal swelling with neck pain	Left parietal tuberculous	MRI scan:- Ring enhancement in Left parietal region	M.Tuberculi	Craniotomy and Excision	No neurological deficit
13	41 year	F	Tingling and numbness in left side of scalp and upper limb	Right thalamus fungal infection	MRI:- altered signal intensity in right thalamus	Aspergillosis	Craniotomy and Excision	No neurological deficit
14	21 year	M	Fever	Right ftp abscess	MRI:- Ring enhancement in right ftp	Staphylococcus	Craniectomy and Excision	Mild neurological deficit
15	25 year	M	Fever, convulsion	Right frontotemporal abscess	MRI:- Ring enhancement in right ft	No organism	Craniectomy and Excision	No neurological deficit
16	7 year	M	Fever, Headache, convulsion	Right ftp abscess	MRI:- Ring enhancement in right ftp	No organism	Craniectomy and Excision	No neurological deficit
17	34 year	M	Headache, convulsion	Right TP Cyst	MRI:- Ring enhancement in right tp	Echinococcus granulosus	Craniectomy and Excision	No neurological deficit

RESULTS

In a prospective case study of 17 patients admitted to the Neurosurgery Unit at the SVP hospital, Ahmedabad between January 2022 and August 2025. All patients underwent lumbar puncture, NEURO imaging, craniotomy or craniectomy and excision and histopathological examination (Table 1). Treatment was initiated based on clinical suspicion and adjusted upon definitive diagnosis. The average follow-up duration was 3 months (range 1-6 months). There were 08 male (47.05%) and 09 female (52.94%) patients, ranging in age from 01 months to 83 years (median 29 years) at the time of diagnosis. At the time of admission, 05 patients complained of headaches and 01 had nausea and vomiting. Eleven patients had fever or signs of meningeal irritation, and neurological deficits were present in six. 13 were alert, and four were confused at admission. Five patients presented with seizures. The mean duration of symptoms was 6 days (range 3-10 days). One patient had a past history of left modified radical mastoidectomy before one year. One patient had congenital heart disease (ventricular septal defect). One patient had an identifiable predisposing cause like pulmonary tuberculosis. There was no identifiable cause in 14 patients. The temporoparietal region was the most common location in 11 patients. The diameter of abscesses on CT imaging ranged from 1.8 cm to 7.2 cm (mean 4.5 cm) at diagnosis. Cerebellar abscess was seen in 02 patients (11.76%). Majority of the patients underwent Craniotomy or craniectomy and excision of abscess except one patient who underwent

aspiration. Repeated aspirations were not required in that patient. In our series, a significant number of patients treated with excision had a favorable outcome ($p < 0.05$). Intravenous steroids were used in all 17 patients. They tapered over 4 weeks. The edema markedly reduced following resolution of the abscess cavity. One patient presented with ventriculitis and hydrocephalus which responded to ventriculostomy with repeated aspirations of CSF and broad-spectrum antibiotics. One patient needed ventriculoperitoneal shunt procedure. Microorganisms were isolated in only ten patients. Streptococcus was identified in two patients, Staphylococcus spp. in three patients, Mycobacterium tuberculosis in two and sterile in six patients. One patient had aspergillosis positive culture with histopathological examination revealed fungal hyphae. One patient had diagnosed hydatid cyst in pathological examination. Broad spectrum intravenous antibiotics were administered on admission, and specific antibiotic therapy as per the sensitivity report was instituted once it was available. Antibiotic therapy was administered for 6 weeks. In patients in whom no organisms were cultured, broad spectrum antibiotic therapy was continued and response was favorable. The overall clinical outcome at the end of 6 months was assessed using the modified Rankin scale (mRS). A good outcome was noted in 88.23% patients (mRS score 0-2) and poor outcome (mRS score >2) was seen in 11.76% patients. The neurological condition at admission and the early institution of treatment strongly correlated with clinical outcome ($p < 0.001$). A mild

residual disability was seen in four patients. Two out of 17 patients died out of which one patient presented in altered sensorium. One patient died of exacerbation of diffuse meningitis and encephalitis. Amongst two patients who died, one had congenital heart disease. In the follow-up period ranging from 3 to 6 months, no recurrence of abscess cavity was noted, none of the patients who survived showed clinical or neuroimaging signs of recurrence. Figure 01 showing pre and post op radiological investigation in different patients.

DISCUSSION

This study highlights the differences in clinical manifestations and outcomes of brain abscesses caused by pathogens. 17.64% of the patients (3/17) had some predisposing factors, and 5.88% (01 patient) had adjacent site infection, including chronic otitis media and mastoiditis. A previous study in a developing country reported otitis media as the most common source of intracranial suppuration [15]. However, this was not the case in our study, possibly due to improvements in the treatment of otitis media in recent decades. It is important to recognize predisposing factors because eliminating the underlying infection helps to avoid prolonged infection. One patient had congenital heart disease (ventricular septal defect). Brain abscess can develop in 5-18% of the population with cyanotic heart disease (CHD). Individuals with CHD are 10 times more prone to develop brain abscess than those with no CHD. Fallot's tetralogy is the most common cause.

These patients possess cardiopulmonary risk, wide variety of coagulation defects and variable degree of immunodeficient states increasing the risk of anesthesia and surgery. Thus, a less invasive surgical procedure such as aspiration should be chosen. [16] The average age of the study participants was 30 years, and 18% of them were aged between 40 and 65 years. There are inconsistent reports regarding the age predilection of brain abscess. Some studies showed that individuals older than 40 years are more susceptible to brain abscess [15], whereas others revealed that brain abscess occurs more often in individuals younger than 40 years [17]. Therefore, the age group that is most affected is difficult to determine, and it may depend on the underlying predisposing factors for brain abscess. Moreover, regardless of age, men

were more susceptible to brain abscess than women at a ratio of 2.8:1. Other authors have reported similar findings [18], although a female predilection was observed in one study [15]. In our study women and men are equally affected (M: F=8/9 0.88%). Headache, fever, and convulsions were the most common symptoms in our study, occurring in 29.41% (5/17), 64.70% (11/17), and 35.29% (6/17) of the patients, respectively; however, this was consistent with previous reports [19]. Headache, fever, and focal neurological deficit are regarded as the classical symptoms of brain abscess. However, a few patients simultaneously experienced all three symptoms [19]. In our study, the classical triad of headache, fever, and hemiplegia was not observed in any patients. The presentations were insidious and atypical, and the absence of this classical clinical triad decreases the likelihood of brain abscess being suspected on initial examination. Indicators of inflammation, such as white blood cell count, erythrocyte sedimentation rate, and C-reactive protein level, play a limited role in the diagnosis of brain abscess [19]. However, not all patients with brain abscess show leptomeningeal involvement, and the role of lumbar puncture in its diagnosis is limited. The rate of brain abscess purulent material culture positivity in our study was 58.82% (10/17). This may be because we initiated antibiotic therapy before obtaining samples for culture, and the standard culture protocol followed at our hospital may result in certain organisms being undetected.

The use of next-generation bacterial sequencing may help to identify more pathogens. In previous studies, the most commonly observed bacteria in patients with brain abscess were those of the streptococcus species [19]. Streptococcus was identified in two patients, Staphylococcus spp. in three patients, Mycobacterium tuberculosis in two and sterile in six patients. Tuberculous brain abscess is rare and can be difficult to differentiate from pyogenic abscess. It results from the caseation of tuberculoma and pus formation due to polymorphonuclear infiltration. The wall is thicker than pyogenic abscess.

Antituberculous therapy along with aspiration of the abscess is advocated. Stereotactic aspiration of the abscess can be performed but there is a risk of neurological worsening and flaring up of tuberculous lesion and hence caution is advised. [20] A tissue diagnosis (by histopathology and mycobacterial

culture) should be attempted whenever possible, either by biopsy of the lesion itself, or through diagnostic sampling from extraneural sites of disease. One patient had aspergillosis positive culture with histopathological examination revealed fungal hyphae. Fungal infections of the central nervous system (CNS) are rare in the general population and are most frequently encountered in immunocompromised patients such as those with acquired immunodeficiency syndrome or after organ transplantation.

Although almost any fungus may cause encephalitis, cryptococcal meningoencephalitis is most frequently seen, followed by aspergillosis and candidiasis. The prognosis of fungal meningitis is dismal. Surgical decompression for large fungal granulomas, especially aspergillus can produce transient improvement due to reduction in the intracranial pressure but eventual outcome is uniformly poor. Open surgery and anti-fungal therapy are the treatment of choice. There are many controversies and unresolved issues in neurosurgical practice like minimal invasive versus total resection of the fungal granuloma, fungal intracranial presentation in immunocompetent patients, high mortality of fungal cases managed without antifungal cover, duration of antibiotics, optimal time and mode of hydrocephalus treatment. [21] One patient had diagnosed hydatid cyst in pathological examination. The epidemiology of echinococcosis is influenced by agricultural, educational, economic, medical and cultural factors. Infection of the central nervous system is rare, and the mainstay of treatment is surgical excision of the intracranial or spinal cyst, when present. At surgery, a large scalp flap should be raised overlying the lesion based on imaging, followed by careful handling of the cyst with meticulous technique and follow the Dowling-Orlando technique. [22]

The most common brain abscess location in our study was the temporoparietal lobe, followed by the frontal lobes, and most of the patients had single lesions. However, another study found that the temporoparietal region is the most common brain abscess location [23]. The location of a brain abscess partly depends on the route of infection transmission. Paranasal sinusitis is often associated with a frontal lobe abscess, and otitis media and mastoiditis are associated with temporal lobe or cerebellar abscesses.

Here, all patients underwent surgery. Most of them underwent craniectomy with excision of abscess. Although craniotomy was once thought to be associated with lower recurrence and mortality rates than stereotactic drainage [24], with the increasing availability of computed tomography, the difference between craniotomy and stereotactic drainage has become uncertain. Even after surgical treatment, long-term antibiotic therapy (4–8 weeks) was necessary. Moreover, 88.23% of the patients, who were independent in daily life, in our study had a good outcome, and only two patients died. The mortality rate, which was approximately 8–53% before 2014, has decreased in recent decades, and it was reported as 4.3% in 2018 [25]. The mortality rate in our study was 11.76% (2/17). We believe that this may reflect selection bias related to patient recruitment from our hospital, which is a tertiary hospital, should be considered.

CONCLUSION

CNS infections are complex, rapidly progressive conditions requiring urgent diagnosis and multimodal management. While vaccines and antimicrobials have reduced the burden, challenges remain in diagnostic delays, antimicrobial resistance, and neurological sequelae. The integration of advanced molecular diagnostics, precision antimicrobial therapy, and NEURO critical care is improving survival. Pyogenic brain abscess should be treated on an emergent basis. Abscess diameters more than 2 cm need surgical intervention and most of them show an excellent clinical and radiological response to single burr-hole aspiration.

Craniotomy is required in selected cases and is a primary procedure in cerebellar, post-operative and post-traumatic abscesses. Intravenous broad spectrum antibiotic therapy should be administered for a period of minimum 6 weeks to prevent relapse. The long-term outcome is gratifying if prompt treatment is instituted in an appropriate time period. Future success depends on global collaboration, equitable access to care, and innovation in diagnostics and therapeutics. A holistic approach—from prevention to rehabilitation—is essential to reduce the global burden of CNS infections.

Study limitations

This study has several limitations. First, the sample size was small. Second, it was a retrospective, single-

center study. Consequently, our findings may not be generalizable to patients in different regions, and some data, including inflammatory marker levels, could not be collected and analyzed. Therefore, multicenter studies with larger samples should be conducted in the future.

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