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External cavitary drainage catheter for large cerebralabscess in high-risk patients: Novel technique

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ABSTRACT

The intracranial abscess is a devastating pathology that the neurosurgical community continues to face in terms of morbidity and overall prognosis despite the advances in diagnosis and outcome. Management of brain abscess is amalgamation of medical and surgical therapies. Currently, craniectomy or craniotomy with excision of abscess and burr hole aspiration of pus are the two surgical therapeutic options available for the management of brain abscess. Here we present a new therapeutic solution for the management of brain abscess in the form of burr hole aspiration followed by continuous drainage of pus through the external cavitary drain catheter.

Keywords: Intracranial abscess, neuro infection, burr hole aspiration, craniotomy, neurosurgery

1. INTRODUCTION

A cerebral abscess is a focal intra-parenchymal suppurative infection that is typically enclosed by a vascularized collagenous capsule. These infections may develop via direct spread from contiguous foci of infection, following head trauma or any neurosurgical procedures. It might also manifest as a result of an infection spreading hematogenously from any distant site. Clinical symptoms and indicators differ significantly from case to case. Typically, the patient presents with headache, altered consciousness, nausea &/or vomiting and high-grade fever. Seizures are another prominent early symptom that affects 25-34% of cases (Hakan et al., 2006). Radiological imaging studies like magnetic resonance imaging (MRI) and computed tomography (CT) along with advances in antibiotics and neurosurgical procedures have resulted in improvements in the outcome of this condition (Carpenter et al., 2007). Complications of brain abscesses are pyogenic meningitis, ventriculitis, mass effect leading to brain herniation, thrombosis of intracranial vessels, stroke, etc. (Bokhari and Mesfin, 2022).

The therapeutic approach of management depends upon various factors such as the size, location and characteristics of the abscess itself along with the individual patient characteristics. The primary aim of cerebral abscess

management includes early diagnosis, prompt surgical removal of pus, simultaneous removal of the source and introduction of antibiotics. Many surgical interventions have been considered such as surgical excision following craniotomy or stereotactic burr hole aspiration of pus. In this study, a novel therapeutic option for surgical management of brain abscess in form of burr hole and aspiration followed by continuous drainage of pus through an external cavitary drainage catheter is presented. The proposed technique is highly useful for the larger abscess in a sick, medically unfit patients, high risk for general anaesthesia.

2. CASE PRESENTATION

Case 1

A 1 yr old female child was brought to the hospital with complaints of vomiting, decreased activity, decreased feed intake for the last 4 days and fever for one day. As narrated by her parents, the child was asymptomatic one month back when she developed discharge from the lower back sacral region followed by cough and cold with decreased feed intake for which she was prescribed amoxicillin-clavulanic acid at a local hospital. The child continued to have decreased feed intake and later developed vomiting with decreased activity and increasing weakness in the right upper and lower limbs. On general examination, the child was afebrile, heart rate was 80/min, respiratory rate 22 cycles per minute and blood pressure 110/70mmHg. Clinical examination was normal for cardiovascular, respiratory and GI systems. A central nervous system examination revealed a depressed sensorium with reduced tone and right hemiparesis grade 1, anterior fontanelle was bulging. Laboratory investigation results are in Table 1. The cerebrospinal fluid examination of the child revealed the features of pyogenic meningitis. Accordingly, she was started on empirical intravenous antibiotics and antiepileptic drugs which led to an improvement in fever but there was no improvement in the neurologic symptoms, so an MRI was done.

On MRI there was evidence of a well-defined moderately large-sized, T2 hyperintense lesion noted in the left cerebral hemispheric parenchyma measuring approximately 6.2 cm x6.6 cm x6.3 cm (AP x Transverse x CC) with surrounding edema as evidenced in Figure 1. Mass effect over the third ventricle along with dilatation of the right lateral ventricle was present. The lesion also caused a mass effect over the brainstem. The periphery of the lesion demonstrated diffusion restriction. In contrast study, thick peripheral rim-like enhancement was evident. The thickness of the rim measured approximately 12.8 mm suggestive of a large intracerebral space-occupying lesion most probably an abscess. A prompt decision to drain the abscess was made. Under local anesthesia, a left frontal burr hole was made and the abscess cavity was tapped along with intracavitary external drain tube placement. The exudate evacuated was examined which revealed plenty of degenerated polymorphs, debris of cells and fibrin exudates with evidence of gram-positive cocci. She was then shifted to the pediatric intensive care unit and was started on inj. vancomycin / meropenem. The external intracavitary drainage tube was left in situ for 5 days. After around 5 days the external drainage tube was removed and the total collection was measured to be around 45ml. After 3 weeks repeat MRI was done that revealed a significant reduction in the size of the abscess, as evident in Figure 2.

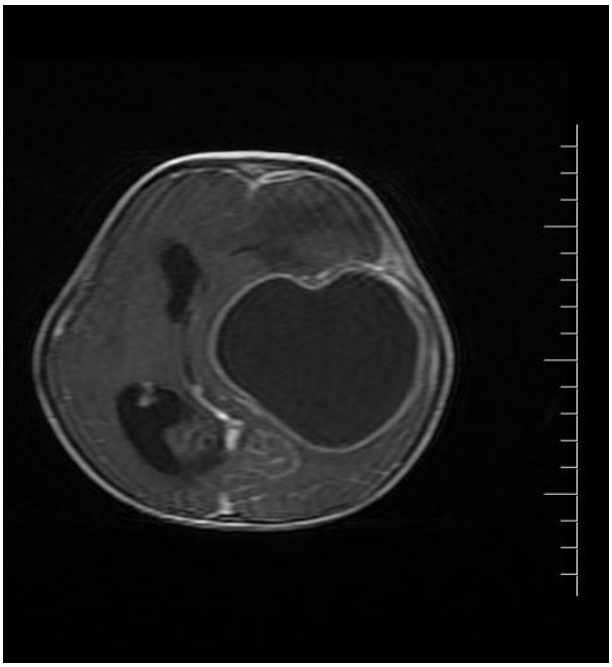

Figure 1 Pre-operative MR scan showing large cerebral abscess with intense enhancement of capsule

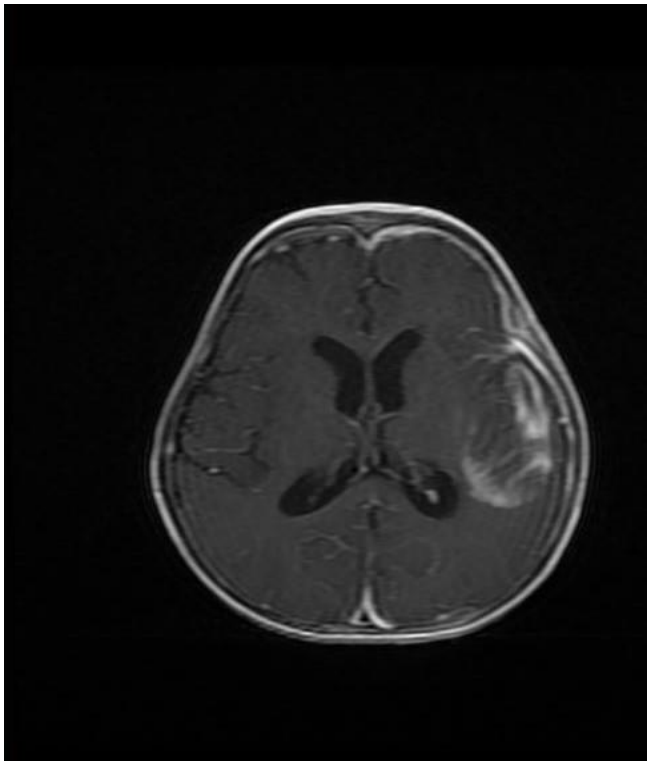

Figure 2 Post-operative scan showing resolution of abscess

She was then continued on intravenous antibiotics which showed improvement in sensorium, tone and posture. Improvement was also seen in the patient's feeding and activity which was returning to near-normal levels. After hospitalization for 2 weeks in the pediatric ward, the patient was discharged in stable condition. She was reviewed after a month and 3 months and found her in a sound general/neurological condition. Her right hemiparesis improved to grade 4.

Case 2

A 7 yr old male child was brought to the hospital with complaints of weakness in his left upper and lower limbs since 1 month. The patient also had complaints of deviation of mouth to right, drooling of saliva and headache since 8 days. As narrated by his parents the child was apparently asymptomatic 1 month back when he developed weakness and pain in both upper and lower limbs of his left side for which he was taken to a local hospital where contrast-enhanced CT was done which was suggestive of a mass lesion with significant surrounding edema. MRI with gadolinium contrast was suggestive of a well-defined lobulated lesion in the right frontal lobe with adjacent vasogenic edema. Diagnosis of brain abscess was made and the patient was referred to our hospital for further management. The child is a known case of cyanotic heart disease with a large Ventricular septal defect with a bilateral shunt diagnosed at 2 months of age.

On general examination, the child was afebrile with a pulse of 86bpm, respiratory rate of 30cpm, BP 102/68 along with mild cyanosis. Clinical examination was normal for respiratory and GI systems. Cardiovascular examination revealed loud S2 with pansystolic murmur. The apex was shifted laterally and downwards. A central nervous system examination revealed a depressed sensorium with reduced tone and power in the left upper and lower limbs. He had an episode of convulsion after hospitalization. The episode lasted for about 2 min and was followed by post-ictal drowsiness. Laboratory investigation results are in Table 1. The blood culture of the patient revealed growth of pseudomonas aeruginosa. Antibiotic sensitivity test revealed sensitivity to ciprofloxacin, meropenem and piperacillin-tazobactam. MRI brain revealed a well-defined lesion appearing heterogeneously hyperintense on T2 with surrounding edema in the right frontal cortex. The lesion also showed restriction on DWI. On contrast administration, peripheral contrast enhancement was seen. As evident in Figures 3, 4, 5.

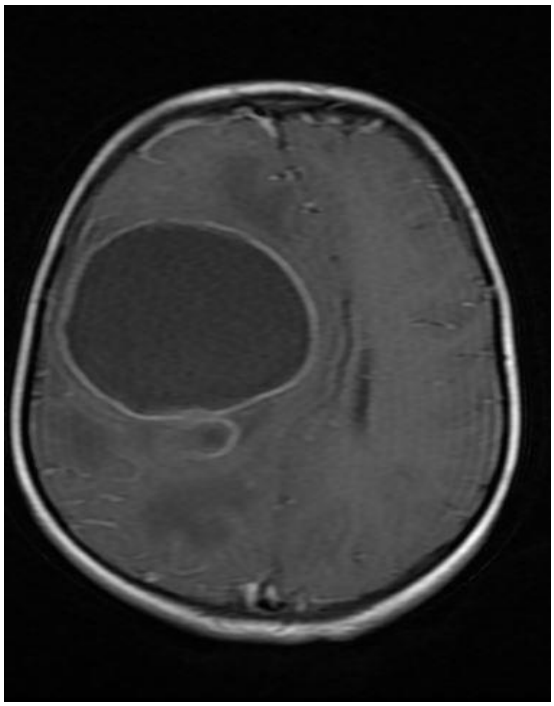

Figure 3 Pre-operative contrast MR scan showing well defined cystic lesion with intense peripheral enhancement

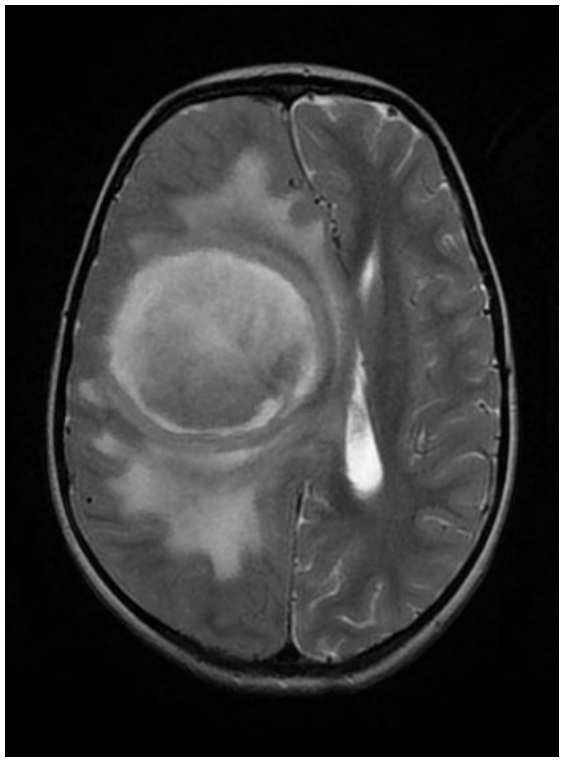

Figure 4 T2W MR images showing massive perilesional edema

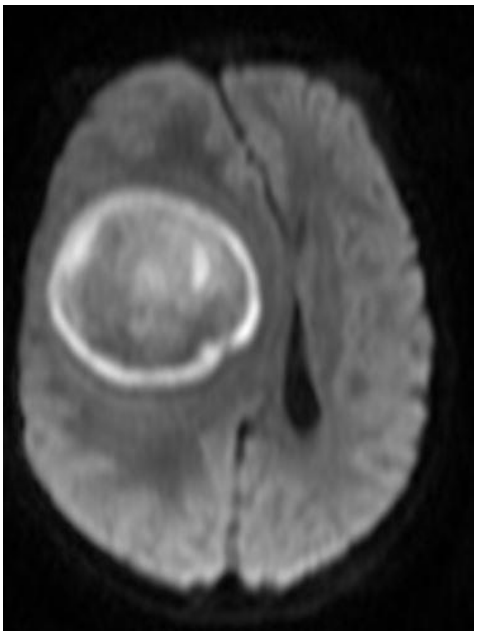

Figure 5 DWI MRI showing diffusion restriction

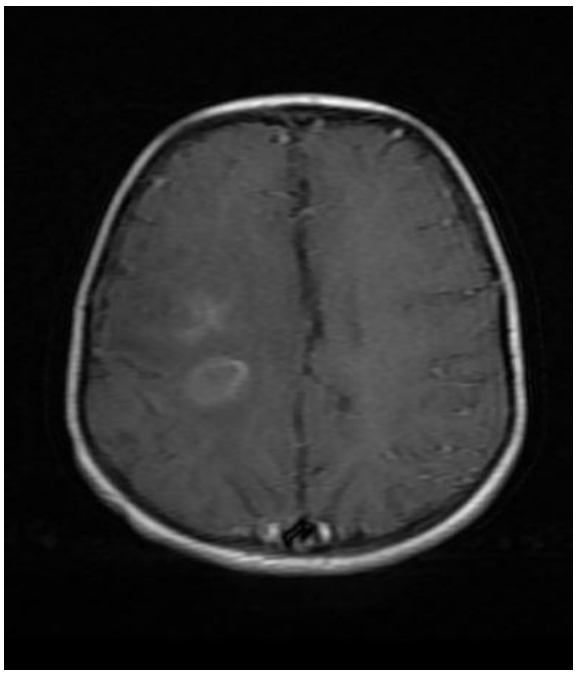

Figure 6 Post-operative scan showing reduction in size of abscess

Four days later the patient had two episodes of fever spikes. In view of the persistent headaches and episodes of fever, the patient was planned for drainage of brain abscess. A high-risk consent was taken in view of cyanotic heart disease and the parents were properly counseled before taking the patient for the procedure. A burr hole was made and the abscess was drained followed by external cavitary drainage tube placement. Around 120 ML of greenish pus was evacuated. Pus culture report was negative. The patient was then shifted to the PICU where the condition of the child was vitally stable. The external cavitary drainage tube was left in situ for about 5 days. After 5 days the drain was removed. Around 35ml of exudate was collected. The neurological condition of the child improved well. He was discharged after 15 days of IV antibiotics.

Table 1 Lab investigations of cases 1 and 2

Investigation	Case 1	Case 2
Hb%	12.1	8.2
RBC Count	6.74	5.86

Hematocrit	41.3	28.2
MCV	61.3	48.2
MCH	17.9	14
MCHC	21.2	29
Peripheral Smear Findings	RBC mass is increased RBCs - Normocytic Normochromic with moderate anisopoikilocytosis showing few microcytic hypochromic RBCs and pencil cells. Platelets - Adequate on smear. No Haemoparasite seen.	RBCs - Microcytic Hypochromic with anisopoikilocytosis showing few pencil cells. Platelets - Adequate on smear. No Haemoparasite seen. Impression: Microcytic hypochromic anemia.
TLC	13100	15900
Platelet	4.37	5.05
Coagulation Profile		
APTT (Control)	29.5	29.5
APTT (Patient)	34.5	43.6
PT (Control)	11.9	11.9
PT (Patient)	13.3	29.3
INR	1.12	2.55
LFT		
ALP	230	198
SGOT	66	26
SGPT	9	10
Total Bilirubin	1.1	0.6
Ditrect Bilirubin	0.6	0.2
Indirect Bilirubin	0.5	0.4
KFT		
SR.Urea	30	26
SR.Creatinine	0.4	0.2
SR.Sodium	141	137
SR.Potassium	3.3	4.5

3. DISCUSSION

Brain abscess was a nearly fatal illness that was rarely identified before autopsy until the late 1800s. Exceptional advancements in the treatment of this illness were made possible by the groundbreaking work of the English surgeon (Macewen, 1893). He demonstrated that certain patients could be treated with abscess drainage using surgical procedures with adequate knowledge of cranial surgical anatomy. After World War II, when medicines like penicillin and chloramphenicol were introduced, the prognosis became much better. The incidence of brain abscess is varied with it being higher in developing countries than in developed countries. This pathology affects all age groups from infants to the elderly with most of the abscesses occurring during the initial two years of life. The ratio of males affected is slightly higher than females (Lu et al., 2006). An intracranial abscess may develop in the cranium from direct spread from contiguous foci of infection, following head trauma or any neurosurgical procedures. It could also develop as a result of the hematogenous spread of infection from any remote location. Based on CT/MRI cerebral abscess evolution can be separated into four stages which include early (1-4 days) & late cerebritis (4-10 days), early (11-14 days) and late capsule formation (>14 days) (Erdogan and Cansever, 2008). Intracranial abscesses manifest mainly as syndromes caused due to focal expansion of the abscess, diffuse neurological necrosis, liquefaction and raised intracranial pressure. It is characterized by focal neurological impairment, altered consciousness, headache, nausea/vomiting, seizures, pain, neck rigidity and occasionally third and sixth cranial nerve palsy. Currently, the management of cranial abscesses involves both medical and surgical modalities. Many

experts suggest the use of medical therapy initially for the treatment of unencapsulated abscesses less than 2.5cm and in patients with good initial clinical condition with a known etiological agent.

Medical management

Depending on the patient's risk factors, broad-spectrum antibacterial agents that can transverse the blood-brain and blood-CSF barriers in sufficient levels should be employed as the first line of treatment. These antibacterial agents include a third-generation cephalosporin, metronidazole and vancomycin if the patient has a penetrating trauma or has recently undergone neurosurgery. In a culture-negative patient, the approach should be according to likely predisposing factors and anatomical location of brain abscess using broad-spectrum antibiotics. Penicillin and its derivatives, third-generation cephalosporins, chloramphenicol, sulfamethoxazole-trimethoprim and metronidazole have all been effectively used as treatments in a variety of combinations and have been proven to reach therapeutic levels in the intracranial exudate. Penicillin derivatives along with chloramphenicol have historically been the mainstays of empiric antimicrobial therapy, according to various experiences. Vancomycin, metronidazole and cephalosporins have since taken their place.

Surgical Management

In 1928, Sargent was the first to record the successful removal of a brain abscess (Sargent, 1928). Historically, surgical drainage techniques have included marsupialization (King, 1925), migration and Dandy's successive tapping of a chronic abscess (Dandy, 1926). The guidelines that govern surgical management, in accordance with the "Infection in Neurosurgery" Working Party of the British Society for Antimicrobial Chemotherapy include aspiration of the cavity under imaging guidance to lower elevated intracranial pressure as soon as possible, verification of the prognosis to collect pus for microbial analysis and to increase the effectiveness of antibiotic treatment to help prevent iatrogenic infection from spreading into the ventricles (Alvis et al., 2013). Due to the high frequencies of negative cultures, emergent draining is therefore recommended for practically all brain abscesses for both therapeutic and diagnostic purposes for identification of the pathogen that is causing the problem. The removal of the purulent exudates is usually enough to start the abscess healing process. However, if the exudate is dense and in abscesses with multiple foci, surgical excision may be ineluctable. Subdural empyema and cerebellar abscess both necessitate urgent abscess evacuation. Currently, craniectomy or craniotomy with excision of abscess and burr hole aspiration are the two surgical therapeutic options available for the management of brain abscess.

Craniotomy and excision of the abscess

Craniotomy and excision of abscess is a procedure involving the creation of a wide opening in the skull and dura mater exposing the full margin of the abscess which may be followed by either complete excision of the capsulated lesion or by open aspiration under ultrasound guidance. In the past, when neither antibiotics nor CT scans were accessible, craniotomies with complete excision were widely advocated. Today however, they are rarely performed and are largely replaced by burr holes or other stereotactic aspirations (Gadgil et al., 2013). If the abscess is caused by a trauma causing inoculation of foreign materials or posterior fossa lesion or mycotic infection suspicion or elevated intracranial pressure because of the substantial mass effect of the brain abscess or if the diagnosis is tricky or recurrence after aspiration, then an open craniotomy approach is still preferred in managing the cerebral abscess combined with medical care and surgical evacuation. Advantages of performing craniotomy include lesser risk of recurrence because of the complete elimination of purulent exudate and enclosing capsule (Mampalam and Rosenblum, 1988) shorter hospitalization stay due to a reduction in the duration of therapy and avoidance of the need for additional therapy. Burr hole aspiration is preferred over craniotomy and open excision due to its complications like hemorrhage, CSF leakage, stroke and seizures and its poor outcome in large, deep-seated abscesses and cerebritis stage (Ratnaike et al., 2011).

Burr hole and aspiration

The burr hole and aspiration treatment involve creating a tiny hole in the cranial vault with a twist drill. This hole causes the formation of an aperture in the dura mater, allowing a cannula to be placed into the cavity and aspiration of the exudates via a needle. It is preferred over craniotomy because of many advantages like the simplicity of the procedure, the ability to approach many lesions without increasing surgical intricacy, less association with mortality, elimination of the need for general anesthesia, being able to decompress lesions in both superficial and deep-seated areas, it can even be used in the cerebritis stage and rapid relief of raised intracranial pressure if present. Although aspiration techniques are now considered the treatment of choice some doctors prefer the craniotomy approach due to various drawbacks. Burr hole with aspiration is associated with a variety of

drawbacks like subarachnoid or subdural leakage of purulent material leading to ventriculitis or meningitis (Hall and Truwit, 2008) inadequate aspiration of purulent material leading to increased recurrence and requirement of multiple aspirations.

Burr hole and aspiration followed by external cavitary drainage tube placement

Burr hole and aspiration followed by external cavitary drain placement is a procedure that involves making a burr hole in the cranium. Upon durotomy, a brain cannula is introduced in the abscess cavity and an external drainage tube is inserted and contents are aspirated followed by fixing of the drain. The tube used was a regular external ventricular drain tube. It's one end is placed in the abscess cavity; another end is connected through a closed circuit to a bag (EVD) and the closure is done in layers after achieving hemostasis. This procedure has significant advantages such as establishment of a way to drain contents without the need to reopen the cranium, establish a way for the application of antibiotics at a local site for effective clearance of microbial causative agents from the abscess cavity, it can be used in patients who are medically unfit to undergo surgery like patients with tetralogy of fallot who have developed a brain abscess. Needle aspiration is a blind procedure and complete evacuation of exudates cannot be confirmed in any possible way. In contrast, an in situ external drain can cause gravity-dependent gradual evacuation of pus and thereby providing symptomatic relief. This is a closed system and is therefore theoretically safer and has fewer chances of reintroduction of infection. However, just like routine EVD assembly, though this is a closed system, it is not infection proof and hence drain is removed after 5 days post-operation.

4. CONCLUSION

In conclusion, despite the development of more advanced and efficient antibacterial chemotherapeutic and radiographic technology, cerebral abscess still poses a significant difficulty. It is crucial to point out that as the population ages and becomes more immunocompromised the latter either as a result of sickness or immunomodulatory medication, if esoteric ideas about intracranial abscesses are not abandoned, this situation will worsen and make the diagnosis and treatment of cerebral abscess more challenging. The occurrence of intracerebral abscesses is not just restricted to underdeveloped nations; it occurs all around the world, but at varying rates. The clinical presentation is varied and its management varies based on presentation and investigations. Integration of both medical and surgical therapies is preferred in most cases. Surgical therapies are case-dependent and include burr hole and aspiration or craniotomy and excision of the abscess. Burr hole and aspiration followed by external cavitary drainage tube placement is a novel therapeutic option that may be performed in patients with brain abscesses considering the characteristics of patients as well as the abscess cavity.

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Author Contributions

All authors contributed equally in this case report.

Informed consent

Written and oral informed consent was obtained from the patient's parents included in the study.

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Conflict of interest

The authors declare that there is no conflict of interests.

Data and materials availability

All data sets collected during this study are available upon reasonable request from the corresponding author.

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