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CONTINUOUS IRRIGATION FOR REFRACTORY MULTIDRUG-RESISTANT BRAIN ABSCESS IN TWO PATIENTS

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ABSTRACT

Introduction: Brain abscesses remain a significant clinical challenge, particularly in cases involving multidrug-resistant (MDR) organisms or failure of standard surgical and medical therapy. Newer adjunctive techniques, such as continuous irrigation therapy, have been explored to enhance infection control and patient outcomes in these complex scenarios.

Case description: We present two cases of brain abscess treated at a tertiary care centre using continuous abscess cavity irrigation after conventional interventions proved insufficient. The first patient, a 15-year-old male, experienced recurrent MDR brain abscesses despite multiple surgical procedures and broad-spectrum antibiotics. Initiation of continuous irrigation, combined with targeted antimicrobial therapy, resulted in rapid clinical stabilisation and marked radiological improvement, with minimal long-term sequelae. The second patient, a 65-year-old female, developed multiple brain abscesses after traumatic brain injury and decompressive surgery. Although continuous irrigation effectively controlled the intracranial infection and imaging confirmed resolution, her neurological recovery was limited due to profound pre-existing brain damage.

Conclusion: Continuous irrigation therapy appears to be a valuable adjunct in the management of refractory or MDR brain abscesses, facilitating rapid infection control when conventional treatments are inadequate. However, ultimate neurological outcomes are largely dependent on the extent of underlying brain injury. These cases highlight the importance of considering continuous irrigation in selected patients and underscore the need for further research and multidisciplinary collaboration to optimise management protocols and improve patient outcomes.

KEYWORDS

Brain abscess, continuous irrigation therapy, multidrug-resistant infection, neurosurgical drainage

LEARNING POINTS

- Continuous irrigation with alternating saline and antibiotic solutions is an effective adjunct in the management of refractory or multidrug-resistant brain abscesses.
- Unfortunately, successful infection control does not always guarantee neurological recovery.

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INTRODUCTION

Brain abscess remains a severe and life-threatening infection of the central nervous system, posing significant diagnostic and therapeutic challenges. Although advances in neuroimaging, neurosurgical techniques and antimicrobial therapy have improved outcomes, prognosis is still guarded, particularly in cases involving multidrug-resistant (MDR) pathogens. Standard management relies on a combination of broad-spectrum intravenous antibiotics and surgical procedures such as aspiration or excision. However, treatment failures remain common, especially with recurrent abscesses, poor antibiotic penetration or resistance to multiple antimicrobial agents, resulting in mortality rates up to 10% in general, and as high as 70% in MDR infections[1,2]. The emergence of MDR organisms such as *Klebsiella pneumoniae* and *Pseudomonas aeruginosa* has further complicated treatment, limiting effective options and necessitating innovative approaches for infection control and drug delivery. Continuous irrigation of the abscess cavity with isotonic saline or antibiotic solutions has been explored as an adjunct to standard care. While small case series have reported its potential benefits, current evidence is limited and there are no established protocols to guide its clinical use[3]. Here, we present two challenging cases of brain abscess managed with continuous irrigation after failure of standard interventions, aiming to highlight both its promise and its limitations in treating refractory MDR brain abscesses.

CASE DESCRIPTION

Case 1: A 15-year-old male with a history of severe traumatic brain injury and multiple prior neurosurgical procedures presented with six weeks of persistent high fever, declining consciousness and purulent drainage from a frontal scalp wound. Despite emergency decompressive craniectomy, ventricular drainage and two abscess evacuations his condition deteriorated, and he required a tracheostomy for airway support. On admission, he was febrile (40°C), moderately obtunded (GCS 13) and had a swollen, pus-draining surgical wound. Laboratory studies showed pronounced leukocytosis and cerebrospinal fluid (CSF) consistent with bacterial infection. Repeated CSF and wound cultures identified multidrug-resistant *K. pneumoniae* and *P. aeruginosa* as the causative pathogens. A brain MRI revealed two well-circumscribed abscesses in the bilateral frontal lobes with extensive surrounding oedema *(Fig. 1)*.

Given the failure of conventional intravenous and intrathecal antibiotics, and the confirmation of MDR organisms, a multidisciplinary team proceeded with repeat surgical debridement and established a continuous irrigation system using a Nelaton catheter for alternating infusion of isotonic saline and antibiotic solutions. The saline was used to mechanically wash out pus and necrotic debris, while the antibiotics provided local antimicrobial activity within the abscess cavity. Antibiotic therapy was escalated and tailored to culture sensitivities. The irrigation rate was carefully titrated and temporarily paused when the patient developed

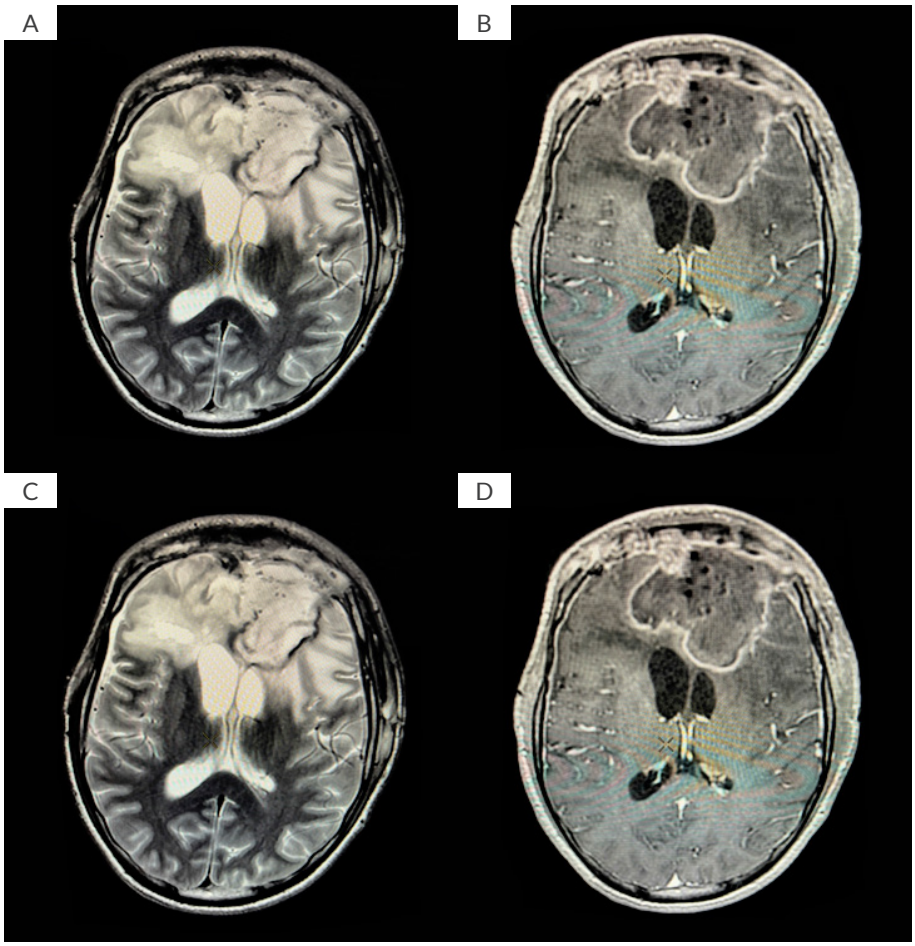


Figure 1. MRI findings following surgery. A) Postoperative day 13, pre-contrast: bilateral frontal lobe lesions containing dense fluid; B) Postoperative day 13, post-contrast: peripheral rim enhancement and meningeal enhancement are noted, with surrounding cerebral oedema, suggestive of recurrent brain abscess; C) Postoperative day 26, pre-contrast: recurrent abscess exhibits increased T2 signal and restricted diffusion on weighted imaging, with adjacent brain oedema; D) Postoperative day 26, post-contrast: peripheral rim enhancement is observed again.

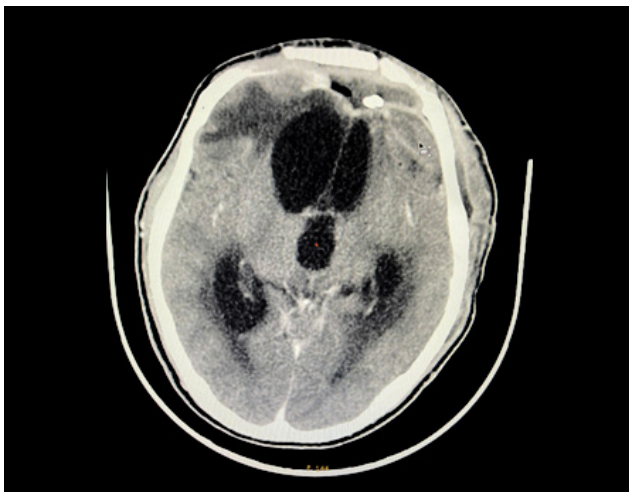


Figure 2. Postoperative CT scan following continuous irrigation. The image demonstrates both the inflow and outflow catheter tips in place. The abscess cavity has been completely evacuated, with residual right frontal cerebral oedema and diffuse ventricular enlargement.

signs of increased intracranial pressure. Continuous monitoring and adjustment of therapy enabled safe and effective management.

Following this intervention, the patient's fever resolved rapidly, his consciousness improved, and wound healing was achieved. Serial laboratory and CSF markers normalised and repeat imaging two weeks later showed marked reduction and eventual resolution of the abscesses and oedema *(Fig. 2)*. After 14 days, the irrigation system was removed, and the patient was discharged without major neurological deficits, aside from mild hearing loss attributed to aminoglycoside ototoxicity. The outcome highlights the safety and efficacy of continuous irrigation as an adjunct in managing refractory, multidrug-resistant brain abscesses *(Fig. 3)*.

Case 2: A 65-year-old woman with no significant past medical history was admitted after a severe motor vehicle accident resulting in an acute subdural haematoma and brain contusion. She was deeply comatose (GCS 6) and underwent emergency evacuation of the haematoma and decompressive craniectomy. Despite successful surgery, she remained comatose with persistent fever and was transferred to the National Hospital for Tropical Diseases. On admission, she required mechanical ventilation; her neurological status did not improve. Physical examination showed no useful responses, but her surgical site was intact. Laboratory work revealed mildly elevated inflammatory markers and slight CSF pleocytosis; however, all CSF and blood cultures were repeatedly negative, complicating the search for a causative organism.

Neuroimaging demonstrated multiple abscess-like lesions scattered throughout the right cerebral hemisphere with extensive oedema, but no midline shift or new bleeding. Broad-spectrum empirical antibiotics were started, but her clinical and radiological status remained unchanged. On the sixth hospital day, surgical drainage and debridement of the abscesses were performed, followed by the establishment of a continuous irrigation system that alternated isotonic saline with appropriate antibiotic solutions. In this protocol, saline was used primarily for mechanical cleansing – facilitating the removal of pus and debris from the abscess cavity – while the antibiotic solution aimed to maximise local antimicrobial exposure directly at the infection site. This irrigation protocol was maintained for 13 days, alongside supportive care and antibiotics, even though a specific pathogen could not be identified.

Following this intervention the patient's fever resolved, and imaging showed a marked reduction in abscess size and cerebral oedema *(Fig. 4)*. No further signs of infection or recurrence developed, and there were no complications from the irrigation system. Unfortunately, her neurological condition did not improve, and she remained deeply comatose and ventilator-dependent. This case highlights that while continuous irrigation with alternating saline and antibiotic solutions can effectively control infection in complex brain abscesses, neurological recovery ultimately depends on the extent of underlying brain injury.

DISCUSSION

The management of brain abscesses has evolved significantly in recent years, combining advances in both surgical and medical therapies to address the dual challenges of infection control and neurological preservation. Traditional approaches have centred on prompt neurosurgical

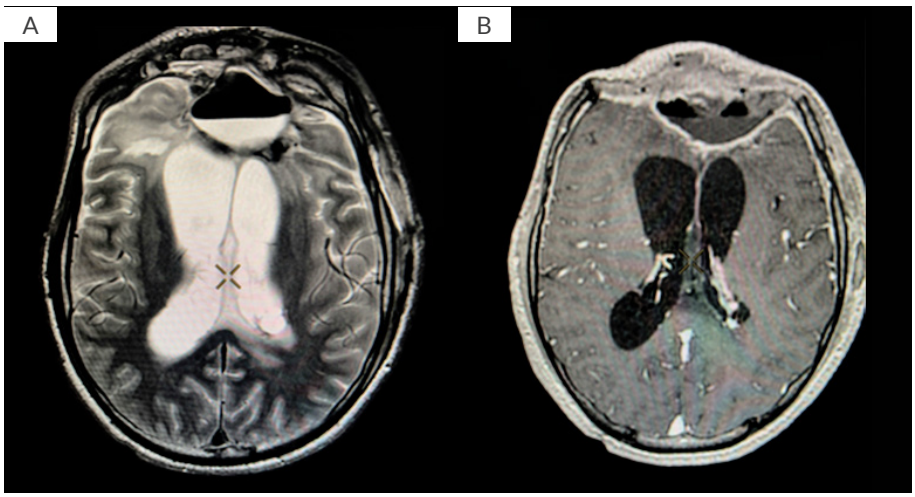


Figure 3. MRI at discharge. A) Marked reduction in abscess size with minimal surrounding oedema; B) Post-contrast imaging shows persistent peripheral rim enhancement at the abscess site with associated ventricular enlargement.

intervention – such as stereotactic aspiration, craniotomy or open evacuation – combined with prolonged intravenous antibiotics, tailored to pathogen sensitivity. Stereotactic aspiration, in particular, offers precise abscess drainage with minimal morbidity and a mortality rate as low as 4%, making it highly effective for chronic or deeply located lesions[4]. For larger abscesses or those causing significant mass effect, open evacuation and irrigation with antibiotic solution may be necessary and has demonstrated high success rates[5].

Continuous irrigation therapy represents a notable innovation in the management of complex and refractory brain abscesses. Originally applied to conditions such as cerebral ventriculitis, continuous irrigation systems – such as the IRRAflow – actively and continuously exchange cerebrospinal fluid and can be combined with intraventricular drug delivery. In a recent multicentre study, the IRRAflow system was associated with significant improvements in neurological status, radiological resolution, and a reduction in mortality compared to conventional drainage methods[6]. These findings underscore the potential of continuous irrigation to improve outcomes, particularly in cases where multidrug-resistant organisms or biofilm formation limit the effectiveness of systemic antibiotics alone.

A recent paper by Yang et al. (2017) has further highlighted the feasibility of continuous irrigation and drainage using a double-cavity sleeve tube in brain abscess management and pointed out that the diagnosis of brain abscess is becoming easier and more prompt with modern neuroimaging[7]. This naturally raises the question of whether continuous irrigation should be implemented earlier in the course of disease, rather than being reserved for cases refractory to conventional treatment. In our second case, the patient was comatose from admission and underwent surgical intervention and continuous irrigation only after persistent infection failed to respond to standard therapy over the first six days. Given the severity of her brain injury and deep coma, it is unclear whether initiating irrigation earlier would have altered her neurological outcome, as her prognosis was dominated by the primary brain insult rather than by uncontrolled infection alone. However, it is conceivable that, in patients without profound neurological damage at presentation, earlier use of continuous irrigation – made possible by early diagnosis – might improve outcomes by limiting infection-related secondary injury and accelerating abscess resolution.

Our cases illustrate the potential role of continuous irrigation as an adjunct to standard neurosurgical drainage, especially in the setting of multidrug-resistant infections where conventional therapy has failed. In Case 1, the implementation of continuous irrigation following recurrent abscess formation and failed antibiotic therapy was associated with rapid clinical improvement, radiological resolution and minimal long-term sequelae. This supports the growing body of literature suggesting that active irrigation and localised antimicrobial delivery can enhance infection clearance, reduce bacterial burden and potentially shorten recovery time[8]. However, as seen in Case 2, even with effective infection control, neurological recovery may be limited by the extent of pre-existing brain injury – highlighting that patient outcomes depend on both infectious and structural factors.

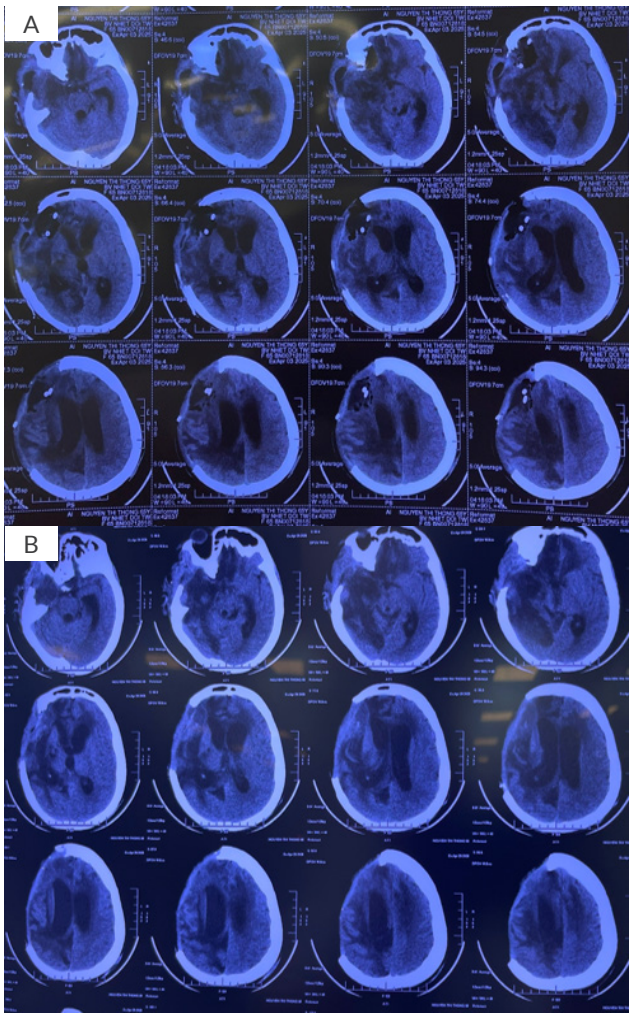


Figure 4. Post-treatment brain CT images showing significant improvement of the abscess, with no residual fluid collection or recurrent pus formation. A) CT scan two days after surgery; B) CT scan 28 days after surgery.

CONCLUSION

In summary, the management of brain abscesses, particularly those complicated by multidrug-resistant organisms or recurrent disease, requires a tailored combination of surgical and medical strategies. Our experience reinforces the value of continuous irrigation as a safe and effective adjunct to standard neurosurgical drainage and targeted antibiotic therapy, facilitating infection control in even the most challenging cases. While this approach can promote rapid clinical and radiological improvement, ultimate neurological recovery is also dependent on the extent of pre-existing brain injury. With advances in early neuroimaging, future studies should evaluate whether earlier implementation of continuous irrigation may further improve patient outcomes, especially in those without irreversible brain damage at presentation. Ongoing multidisciplinary collaboration and

further research are essential to optimise protocols, improve patient outcomes and establish evidence-based guidelines for the use of advanced techniques such as continuous irrigation in brain abscess management.

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