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Case Report

Management of sinogenic subdural empyema in a 9-year-old child via minimally invasive burr-hole evacuation: a case report

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Abstract

We present here a case of a 9-year-old boy who was admitted with a dramatic neurological decline caused by bilateral subdural empyema secondary to pansinusitis. His symptoms included right-sided hemiplegia, global aphasia, and altered consciousness. Although aggressive, the initial antibiotic therapy failed to halt his deterioration, and an emergency surgical intervention became necessary. The patient underwent minimally invasive evacuation via two neuronavigated burr-hole craniotomies, which successfully drained the purulent collections. Postoperatively, he was managed with a multimodal regimen including broad-spectrum intravenous antibiotics, antiepileptic drugs, and a tapering course of corticosteroids. While intraoperative pus cultures were sterile, *Streptococcus anginosus* was isolated by blood culture, guiding a targeted six-week course of vancomycin and levofloxacin. The patient experienced a rapid and complete neurological recovery, with follow-up imaging confirming resolution of the empyema. This case highlights the efficacy of combining minimally invasive surgery with aggressive, tailored medical management for treating severe pediatric SDE, leading to an excellent outcome.

Keywords

burr-hole evacuation, childhood, subdural empyema

Introduction

Subdural empyema (SDE), a collection of purulent material between the dura and arachnoid mater, is a formidable neurosurgical emergency.[1,2] In the pediatric population, SDE represents a life-threatening intracranial infection that can lead to rapid neurological deterioration and significant long-term morbidity if not managed urgently.[3] The most common precursor in older children is paranasal sinusitis, with infection spreading either by direct extension or, more frequently, via retrograde thrombophlebitis through valveless emissary veins.[4]

The clinical presentation is often fulminant, driven by the mass effect of the purulent collection, cortical irritation, and the risk of septic venous thrombosis leading to cerebral infarction. Management necessitates a combined approach: prompt surgical evacuation of the empyema and a prolonged course of broad-spectrum intravenous antibiotics.[3] Although modern diagnostics and treatment have decreased mortality rates to as low as 6%–15%, morbidity remains high, with up to half of survivors experiencing long-term neurological deficits such as hemiparesis or persistent seizures.[5]

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The most common causative organisms are aerobic and anaerobic streptococci, staphylococci, and *Haemophilus influenzae*.[6] Infections caused by sinusitis in children are particularly associated with the *Streptococcus anginosus* group, which is present in a high percentage of cases.[4,7]

This report presents a complex case of bilateral SDE secondary to pansinusitis in a 9-year-old boy, managed with minimally invasive neuronavigated evacuation and multimodal medical therapy.

Case presentation

A 9-year-old male patient with a normal developmental history presented with a 10-day illness that began with fever and progressed to profound malaise, somnolence, vomiting, new-onset seizures, right-sided weakness, and speech disturbances. The child was initially treated with oral antimicrobial therapy (amoxicillin/clavulanic acid) but after a rapid deterioration was admitted in the Intensive Care Unit of Prof. Ivan Mitev Pediatric Hospital with suspected purulent meningitis and treated empirically with vancomycin, meropenem, and clindamycin for three days. His condition worsened to right-sided hemiplegia and global aphasia. Magnetic resonance imaging (MRI) revealed bilateral SDE and pansinusitis ***(Fig. 1)****, prompting emergency transfer to our neurosurgical department (St. Ivan Rilski University Hospital).*

On admission, the patient was febrile with a Glasgow Coma Scale (GCS) score of 9, right-sided hemiplegia, global aphasia, and signs of meningeal irritation. Laboratory tests showed marked inflammatory activity – leukocytosis (26.30×10^9/L) and a C-reactive protein (CRP) of 219.20 mg/L.

The patient underwent emergency surgery on the day of admission. Two neuronavigated burr-hole craniotomies were done, centered over the areas of maximal pus accumulation – 2 cm behind the right-sided stephanion (intersection of the coronal suture and superior temporal line) and left-sided parasagittal one ***(Fig. 2)****.*

Thick pus was evacuated from the subdural space, and samples were taken for microbiology culture. The adjacent subdural space (within a 5-cm radius of the burr hole) was drained intraoperatively by a silicon catheter and irrigated by normal saline with 50 mg of amikacin dissolved in it. At the end of the procedure the subdural space was completely obliterated by the expanding brain, and virtually all of the irrigated fluid and pus were removed. The burr holes were covered by titanium plates with no postoperative drainage left.

Postoperative antimicrobial therapy included an empirical combination of intravenous vancomycin (300 mg every 6 hours), levofloxacin (250 mg every 12 hours), and metronidazole (250 mg every 8 hours). Dexamethasone was administered at a dose of 4 mg every 12 hours for 10 days, followed by a taper to 4 mg once daily. Postoperatively, the patient experienced several Jacksonian seizures, which were controlled with intravenous diazepam, and an antiepileptic drug regimen (valproic acid and levetiracetam) was initiated.

Within the first five postoperative days, the patient showed significant clinical improvement. Inflammatory markers declined, with the C-reactive protein (CRP) level decreasing to

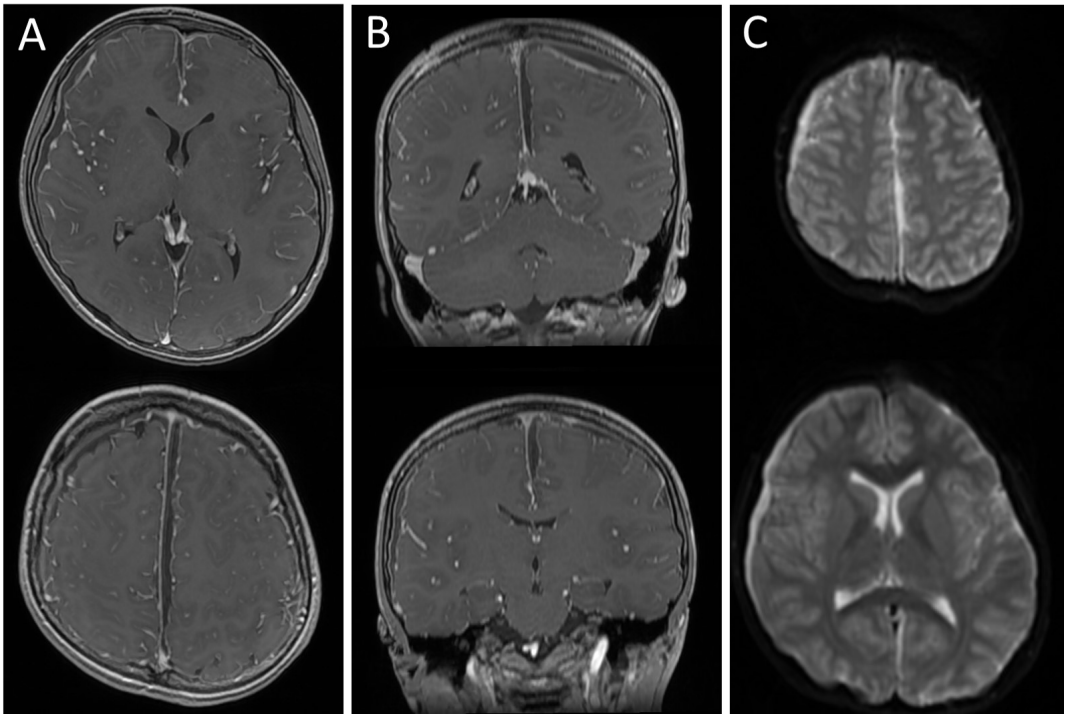

Figure 1. Preoperative MRI. **(A, B)** Axial and coronal contrast-enhanced T1-weighted images demonstrate bilateral subdural empyemas. The empyema is situated over the lateral convexity on the right and along the parasagittal convexity and medial surface of the left hemisphere. **(C)** Diffusion-weighted imaging reveals restricted diffusion in the same locations, consistent with pus.

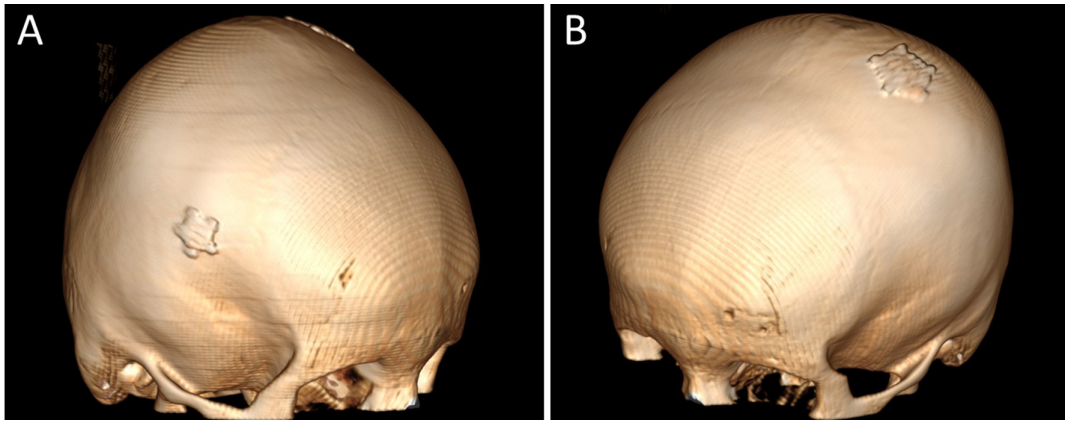

Figure 2. Postoperative three-dimensional CT reconstruction of the skull. Image **(A)** shows the right burr hole (2 cm posterior to the stephanion), and image **(B)** shows the left parasagittal burr hole. Both sites, used for empyema evacuation, are covered with titanium plates.

26 mg/L. Neurologically, the hemiparesis improved to a muscle strength of 3/5 on the MRC scale, and the sensory aphasia almost completely resolved, although the motor aphasia persisted. Improvement continued at a slower pace in the following 7 postoperative days (until discharge) when the child was able to walk with aid and speak short sentences.

Intraoperative cultures from the empyema material remained sterile, but one of the blood cultures drawn on admission returned positive for Streptococcus anginosus *on the sixth day postsurgery. It was susceptible to two of the drugs from our empirical combination – vancomycin and levofloxacin.*

Twelve days after surgery, the patient was transferred back to the pediatric facility (Prof. Ivan Mitev Pediatric Hospital) to complete a six-week course of intravenous antimicrobial therapy with vancomycin and levofloxacin. Upon completion of this treatment, all neurological symptoms had completely resolved. Follow-up MRI studies, conducted 2 and 6 months

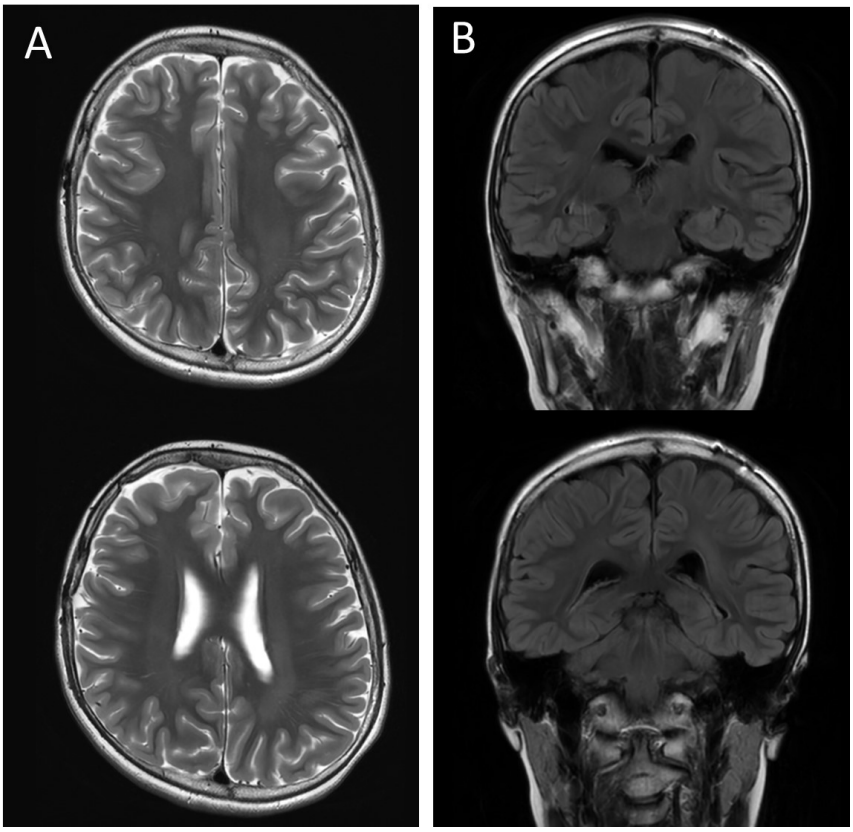

Figure 3. Postoperative MRI at 6-month follow-up. Axial T2-weighted **(A)** and coronal FLAIR **(B)** images show complete resolution of the bilateral subdural empyema.

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after surgery ***(Fig. 3)****, revealed no pathological changes.*

Discussion

This case illustrates the critical principles of managing severe pediatric sinogenic SDE. The patient's rapid decline, despite initial treatment with oral and then intravenous broad-spectrum antibiotics, underscores that medical therapy alone is insufficient once an encapsulated purulent collection has formed, necessitating immediate surgical source control.[1,3]

Microbiology and pathogenesis

The isolation of *Streptococcus anginosus* is a key finding. This organism is a member of the Streptococcus anginosus group (SAG), which are well-documented pathogens in sinogenic intracranial infections and are renowned for their potent pyogenic capabilities.[8] Their virulence is linked to the production of tissue-destructive hydrolytic enzymes and cytotoxins that facilitate liquefaction and abscess formation.[7] The paradox of a positive blood culture with a sterile intraoperative pus culture is a recognized phenomenon, likely resulting from the partial sterilization of the localized empyema by the pre-surgical antibiotic courses.[2] This highlights the crucial diagnostic value of obtaining blood cultures early, as they may provide the only positive microbiological evidence to guide targeted therapy, especially when advanced molecular diagnostics on pus samples are not performed.[2] The confirmed susceptibility of the isolated *S. anginosus* to vancomycin and levofloxacin validated the empirical postoperative antibiotic regimen and was instrumental in the patient's complete recovery.

Surgical management

Due to the rarity of pediatric SDE (annual incidence estimated at less than 1 case per 100,000 children), the literature lacks large-scale comparative studies on treatment modalities, preventing the establishment of firm, evidence-based recommendations for specific surgical approaches or medical management alone.[2] Nevertheless, because subdural empyema is a life-threatening condition, an aggressive surgical approach is often warranted.[2,5,9-12] The surgical approach for SDE has traditionally involved a choice between a large craniotomy for thorough debridement and smaller burr holes for drainage. Craniotomy offers wide exposure and allows for direct visualization and removal of purulent membranes, but at the cost of greater surgical morbidity.[13] Conversely, burr holes are less invasive but have been associated with a risk of incomplete evacuation and higher rates of recurrence, particularly with thick, loculated pus.[12]

The technique used here—neuronavigated burr-hole craniotomies—represents a modern, minimally invasive evolution that synthesizes the advantages of both traditional methods. Neuronavigation provides a real-time, three-dimensional view, based on preoperative imaging information, allowing the surgeon to precisely target the largest portions of the purulent collection through minimal cranial openings.[13] This maximizes the efficacy of drainage while maintaining the low morbidity profile of a less invasive procedure.[12] The use of burr holes as an effective treatment has been supported by multiple studies, especially when guided by modern imaging, challenging the notion that craniotomy is always superior.[14]

A notable aspect of this case was the decision to not leave a postoperative drain. While some surgeons utilize continuous irrigation and drainage systems to manage residual pus and prevent re-accumulation[9,10], this case demonstrates that it is not always necessary. The complete re-expansion of the brain intraoperatively, following thorough irrigation with an antibiotic solution, obliterated the subdural space and indicated successful source control. The patient's complete clinical and radiological recovery, with no recurrence on follow-up imaging, validates the efficacy and safety of this tailored, minimally invasive approach without postoperative drainage.

Medical management and adjunctive therapies

The cornerstone of SDE management, alongside surgery, is aggressive antimicrobial therapy. The initial empirical regimen should be broad-spectrum, with good central nervous system (CNS) penetration, to cover the most likely pathogens, including *Streptococcus* species, *Staphylococcus aureus*, and anaerobes, which are common in sinogenic infections.[2] In this case, the postoperative empirical combination of vancomycin, a fluoroquinolone (levofloxacin), and metronidazole provided excellent coverage. The subsequent isolation of *Streptococcus anginosus* from blood culture, a pathogen known for its high susceptibility to beta-lactams and vancomycin[7], allowed for the refinement of the antibiotic regimen. The confirmed susceptibility to vancomycin and levofloxacin validated the ongoing treatment and was instrumental in the patient's recovery. The duration of antibiotic therapy for SDE is prolonged, typically lasting 4 to 8 weeks, with at least 2 to 6 weeks administered intravenously to ensure complete eradication of the infection and prevent relapse.[1-4] The six-week course prescribed for this patient aligns with these established guidelines.

The role of certain adjunctive therapies in SDE management remains debated. In this patient, the administration of a tapering course of dexamethasone was associated with a significant and rapid improvement in his neurological deficits. While high-level evidence from large randomized trials is lacking, and its use remains controversial[15], case reports and series suggest that corticosteroids can be beneficial in patients with severe cerebral edema and mass effect by mitigating the host inflammatory response. In critically ill patients, short-term steroid use may serve as a life-saving bridge, reducing intracranial pressure while definitive sur-

gical and antibiotic treatments take effect.[16]

Seizures are a frequent and serious complication of SDE, with studies reporting an incidence of up to 56% due to direct cortical inflammation and irritation.[2] Some sources advocate for routine prophylaxis in all SDE patients because of the high incidence of both preoperative and postoperative seizures.[11] The clinical course of our patient exemplifies this high epileptogenic risk. Prophylactic valproic acid was initiated preoperatively; however, this monotherapy proved insufficient, as the patient developed frequent partial motor seizures in the postoperative period. This prompted an escalation of the treatment regimen with the addition of levetiracetam. The subsequent dual antiepileptic therapy was effective in achieving complete seizure control. The optimal duration and intensity of antiepileptic therapy remain unclear in the literature, with clinical practices ranging from a short course for the acute phase to maintaining medication until the patient is seizure-free for two years.[1,2,5,9,11,15]

Conclusion

This case of severe pediatric subdural empyema underscores the efficacy of a multidisciplinary approach. Minimally invasive neuronavigated surgery, targeted antibiotics, and adjunctive medical therapies resulted in a complete recovery, highlighting the importance of prompt, aggressive management.

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Additional information

Ethical statements

- The authors declared that no clinical trials were used in the present study.
- The authors declared that no experiments on humans or human tissues were performed for the present study.
- The authors declared that no informed consent was obtained from the humans, donors or donors' representatives participating in the study.
- The authors declared that no experiments on animals were performed for the present study.
- The authors declared that no commercially available immortalized human and animal cell lines were used in the present study.

Conflict of interest

The authors have declared that no competing interests exist.

Artificial Intelligence (AI) use

Regarding the use of AI in the preparation of this manuscript, the authors declare the following: we have used AI for English language editing.

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Data availability

All of the data that support the findings of this study are available in the main text.