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Subdural empyema complicating Streptococcus pyogenes meningitis in an immunocompetent child: a case report

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Case Report

Keywords: children, meningitis, sinus disease, bacterial infections, Streptococcus pyogenes, complications, subdural empyema, diagnosis, treatment

Posted Date: April 23rd, 2026

DOI: https://doi.org/10.21203/rs.3.rs-9447959/v1

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Additional Declarations: No competing interests reported.

Abstract

Background

Streptococcus pyogenes (group A β-haemolytic streptococcus, GAS) is a common cause of infections in children; however, invasive forms involving the central nervous system are extremely rare. Meningitis caused by GAS accounts for less than 1% of all cases of bacterial meningitis and is associated with high mortality and a significant risk of neurological complications. Intracranial purulent complications, particularly subdural empyema, are among the least well-documented forms of invasive GAS infection.

Case presentation

We report a case of an immunocompetent 17-year-old adolescent with acute bacterial meningitis, developed after an upper respiratory tract infection. The course of the disease was complicated by pansinusitis and the formation of bilateral frontal-parietal subdural empyemas with concomitant encephalitic changes. Streptococcus pyogenes was identified as the causative agent in the cerebrospinal fluid. Initial empirical treatment with vancomycin and ceftriaxone led to partial improvement; however, a subsequent deterioration in the patient's condition necessitated repeat neuroimaging and adjustment of the antimicrobial therapy. Prolonged treatment resulted in a gradual improvement in clinical, laboratory and imaging findings. The patient was treated conservatively without neurosurgical intervention and discharged in a satisfactory condition with regression of neurological symptoms.

Conclusions

Despite the rarity of subdural empyema caused by S. pyogenes, it should be considered in the differential diagnosis in children and adolescents, especially in the presence of concomitant sinonasal infection. The present case highlights the importance of early diagnosis, timely use of neuroimaging, and dynamic correction of antibiotic therapy. A multidisciplinary approach is key to preventing severe complications and achieving favourable clinical outcomes.

Background

Streptococcus pyogenes (group A β-hemolytic streptococcus, GAS) is a well-known pathogen of common infections in children, most frequently impetigo, pharyngitis, and scarlet fever. Although the vast majority of GAS infections are noninvasive, in rare cases this pathogen can cause severe invasive diseases, including necrotizing fasciitis, pneumonia, sepsis, and streptococcal toxic shock syndrome [1,2]. Intracranial purulent complications caused by S. pyogenes, including subdural empyema, are extremely rare and are represent some of the least described inflammatory forms of invasive streptococcal infection [2]. Despite their low incidence, such conditions are associated with high mortality and an increased risk of long-term neurological sequelae [1,2,3].

This article presents a rare clinical case of subdural empyema caused by S. pyogenes in an immunocompetent adolescent boy with the aim of supplementing the limited literature and emphasizing the importance of early diagnosis and timely multidisciplinary monitoring and treatment of this life-threatening condition. The study was approved by the Bioethics Committee of Zaporizhzhia State Medical and Pharmaceutical University and conducted in accordance with the Declaration of Helsinki. Written informed consent to publish this clinical case and the accompanying images was obtained from the patient and his parents.

Case presentation

An immunocompetent 17-year-old boy without a significant medical history was admitted to the intensive care unit of a regional infectious diseases clinical hospital with complaints of a five-day history of fever up to 40 °C, headache, vomiting, photophobia, weakness of the left leg and a small-dot rash on the skin.

The medical history indicates that the boy developed acute symptoms, including a high temperature, headache, nasal congestion and rhinorrhea. He was given antipyretics. On the 5-6th day of the illness, a small-dot rash appeared on the skin, mainly on the lower part of the trunk, along with weakness and involuntary twitching in the left leg. The patient consulted a general practitioner and were referred for hospitalization to the regional infectious diseases hospital. The child was vaccinated according to the national vaccination calendar. Further study of the patient's medical history and family history revealed no significant factors predisposing to severe infectious diseases or immunodeficiency.

On admission, the child was conscious and responsive, but in a serious condition due to severe endotoxemia and neurological symptoms. His body temperature was 39°C, the skin was pale, and paresis of the left lower limb was noted. Meningeal signs were positive. A blood sample was obtained for general clinical studies, a cerebrospinal fluid (CSF) sample was collected for general clinical analysis, and a bacteriological culture of the CSF was performed to determine the bacterial flora and sensitivity to antimicrobial drugs. Laboratory tests revealed the presence of leukocytosis, with a white blood cell count up to 19.2×10^9/l, marked neutrophilia (7% band neutrophils, 87% segmented neutrophils), lymphopenia (4%), and elevated erythrocyte sedimentation rate (ESR) of 52 mm/h. Lumbar puncture revealed cloudy CSF, with pronounced neutrophilic pleocytosis (total cell count 11,093/μL, 96% neutrophils), no red blood cells, elevated protein level (0.66 g/L), low glucose level (1.3 mmol/L), and insignificantly low chloride level (100 mmol/L). Based on the clinical and laboratory findings, a preliminary diagnosis of purulent meningitis with cerebral edema was established. Empirical intravenous antibiotic therapy with vancomycin and ceftriaxone was initiated in accordance with the Evidence-Based Medicine Guideline 00604 “Meningitis in Children” an evidence-based medicine guideline developed by DUODECIM Medical Publications [4].

The patient responded well to the prescribed treatment with remission of fever and other symptoms within 48 hours of starting antibiotic therapy. On the 3rd day, subjective improvement was noted, but the

general condition remained severe due to cerebral and neurological symptoms. Bacteriological analysis of the cerebrospinal fluid identified Streptococcus pyogenes, which was susceptible to azithromycin, clarithromycin, moxifloxacin and vancomycin. Based on these results, antibiotic therapy was corrected: vancomycin was continued at a dose of 900 mg four times daily and the dose of ceftriaxone was reduced to 1 g twice daily. An otolaryngology consultation established a diagnosis of acute nasopharyngitis, acute otitis media on the right and pansinusitis. Neurological evaluation resulted in a diagnosis of bacterial meningoencephalitis with moderate meningeal syndrome, right-sided dissociated hemiparesis, left-sided pyramidal syndrome. Based on clinical and laboratory findings and consultations with specialists, a final clinical diagnosis was established: Acute severe purulent meningitis caused by S. Pyogenes. Pansinusitis. Complications: cerebral edema and swelling of the brain.

During this period, the first head Magnetic Resonance Imaging (MRI) was performed, revealing signs of widespread leptomeningitis of the cerebral hemispheres with formation of planar subdural empyemas in the frontal-parietal areas of both cerebral hemispheres; reactive edema of the parietal bone marrow; a developmental venous anomaly of the superior portion of the cerebellar vermis; signs of an inflammatory process in the right paranasal sinuses (Fig. 1).

Table 1 presents the dynamic changes in hematological parameters, where we can observe that on the 15th day of antibiotic therapy, the white blood cell count normalized from 19.2 × 10^9/l to 7.2 × 10^9/l, an increase in the percentage of lymphocytes from 4% to 23%, while a persistently high ESR of 42 mm/h. This trend persisted on the 18th day of treatment.

The results of the CFS analysis (Table 2) demonstrated positive dynamics on the 12th day of antibiotic therapy, with a decrease in the total cell count from 11,093/μL to 69 /μL and a shift from neutrophilic pleocytosis (96% neutrophils) to lymphocytic (94% lymphocytes), and normalization of the protein level from 0,66 g/L to 0,46 g/L.

Table 1 Dynamics of hematological parameters during hospitalization

Investigation	Day 1	Day 15	Day 18
Hemoglobin (g/L)	118	125	149
Erythrocytes (×10^{12}/L)	3.7	3.9	4.29
Leukocytes (×10^{9}/L)	19.2	7.2	7.8
ESR (mm/h)	52	42	56
Eosinophils (%)	0	0	3
Band neutrophils (%)	7	3	4
Segmented neutrophils (%)	87	68	71
Lymphocytes (%)	4	23	16
Monocytes (%)	-	5	6
Thrombocytes (×10^{9}/L)	219	300	363

Abbreviations: ESR – erythrocyte sedimentation rate.

Table 2 Cerebrospinal fluid findings during hospitalization

Day (from admission)	Day 1	Day 12
Total cells (cytosis, /μL)	11093	69
Neutrophils (%)	96	6
Lymphocytes (%)	4	94
Glucose (mmol/L)	1.3	2.6
Protein (g/L)	0.66	0.46
Chlorides (mmol/L)	100	102

On the 10th day of hospitalization, against the background of improvement in the patient's general condition, it was decided to switch from parenteral to oral antibiotic therapy, however, the patient's condition deteriorated again, necessitating a control brain MRI (Fig. 2), which revealed a significant reduction in the severity of visual signs of subdural empyema and right-sided sinusitis, but the appearance of focal inflammatory signs in the frontal regions of the brain, predominantly on the right side.

Between the initial MRI scan and the second, the leptomeningeal inflammatory process consistent with leptomeningitis remained stable in terms of both volume and intensity, with persistent diffuse contrast enhancement of the meninges up to 8 mm in thickness, indicating incomplete resolution of the primary meningeal inflammation. The subdural empyemas, which were visible on both sides in the frontal-

parietal areas (up to 6 mm thick and containing proteinaceous fluid) on the initial scan, had significantly regressed, indicating a positive response to treatment. However, this improvement was accompanied by progression to parenchymal brain damage, manifested by new encephalitic changes in the frontal lobes —predominantly on the right—as well as changes typical of the development of cerebral edema or early abscess formation as a complication of empyema. This parenchymal enlargement has resulted in a mild mass effect, including a 4 mm shift of the midline to the left and slight compression of the anterior horn of the left ventricle, which were previously absent. This potentially reflects increased intracranial pressure or focal tissue edema. Right-sided sinusitis has improved, with reduced thickening of the mucous membrane in the frontal and ethmoid sinuses, although persistent changes in the maxillary sinus remain without any limiting signs. The venous malformation of the cerebellar vermis and other intracranial structures remained stable, with no new vascular or structural abnormalities. The evolution indicated partial control of the extracerebral infectious components (subdural empyema and sinusitis), but progression to intracerebral involvement.

Taking into account the results of the repeated MRI and the deterioration of the patient's general condition, it was decided to replace parenteral antibiotic therapy from ceftriaxone to meropenem at a dose of 2 g 3 times a day.

The signs of encephalitis identified during the repeated MRI needed to be differentiated from the formation of a brain abscess and ischemic changes; therefore, the patient was transferred for further investigation and decision making on surgical intervention to the neurosurgery department of the children’s hospital. The neurosurgeons found no indication for surgical treatment, as the MRI did not reveal any large purulent areas of the brain (small size (≤6 mm)), no mass effect requiring drainage; therefore, it was decided to continue the previously prescribed parenteral antibiotic therapy, under the control of Computed Tomography (CT) and clinical and laboratory tests.

The results of the CT performed on the 24th day of treatment revealed that the CT findings corresponded to areas of toxic-ischemic changes / post-inflammatory gliosis in the frontal areas of both cerebral hemispheres, against a background of a previous neuroinfectious process. The right-sided sinusitis and ethmoiditis had resolved.

The patient was discharged from the hospital on the 40th day of treatment. At the time of discharge, the child was conscious, in satisfactory condition; cerebral and neurological symptoms had regressed, and meningeal signs were negative. According to the results of the general clinical analysis of the cerebrospinal fluid, cytosis of 10 cells and the protein level of 0.072 g/L were detected, the bacteriological examination of the cerebrospinal fluid for flora revealed no growth.

The patient received parenteral antibiotic therapy with changes to the medication based on the severity of his general condition and clinical, laboratory and instrumental findings throughout the entire period of hospitalization. Upon discharge, the patient was given recommendations to continue oral antibiotic therapy with moxifloxacin for 14 days.

Discussion

According to the literature, more than 1.2 million cases of bacterial meningitis are reported worldwide each year, with Neisseria meningitidis, Streptococcus pneumonia and Haemophilus influenza remaining the most common causative agents [5]. The proportion of meningitis caused by Streptococcus pyogenes is extremely low - less than 1% of all cases of bacterial meningitis. The pathogenesis of meningitis caused by S. pyogenes has not been fully elucidated. It is believed that the infection usually develops against the background of bacteremia or spreads from a primary focus, most often localized in the upper respiratory tract (otitis, mastoiditis, sinusitis, tonsillitis). At the same time, despite the high prevalence of S. pyogenes colonization in young children, lesions of the central nervous system occur extremely rarely [6].

The uniqueness of the problem of purulent complications of meningitis is due to their rarity and, at the same time, a high risk of fatal outcomes in case of untimely diagnosis and treatment. In most cases described in the literature, the disease has an acute and severe onset with hyperthermia, pronounced neurological symptoms and, in some cases, preceding infections or trauma [7].

A clinical case of pyocephaly, subdural empyema and diffuse leptomeningitis caused by Streptococcus iniae in a 69-year-old man from India with concomitant hypertension and diabetes mellitus is available for review. A severe invasive infection was diagnosed, and treatment included prolonged intravenous therapy with ampicillin and vancomycin [8]. At the same time, subdural empyema is a rare complication of meningitis, which is more commonly associated with Streptococcus pneumonia and Haemophilus influenza type b than with Neisseria meningitidis. The first reports of meningococcal-associated subdural empyema in infants date back to 1951. In particular, a 3-month-old infant with bacterial meningitis was described, in whom MRI revealed bifrontal and bitemporal subdural empyema with leptomeningeal thickening. Following craniotomy with evacuation of pus (3 ml) and 3 weeks of antibiotic therapy, Polymerase Chain Reaction confirmed Neisseria meningitidis serogroup B, and the child recovered [9].

A case of an 8-year-old boy with acute onset of fever, severe headache, and vomiting following an upper respiratory tract infection has also been reported. The examination revealed meningeal symptoms, impaired consciousness, and focal seizures. MRI confirmed subdural empyema and meningoencephalitis against a background of sinusitis; the causative agent was Streptococcus pneumoniae. Prompt neurosurgical intervention combined with targeted antibiotic therapy ensured complete recovery [10].

Known risk factors for GAS-induced central nervous system infections include neonatal age, previous neurosurgical interventions, skull fractures, cerebrospinal fluid leakage, the presence of a ventriculoperitoneal shunt, and immunosuppressive conditions [2,11]. However, cases of the disease in previously healthy patients with no obvious risk factors have also been described [11].

Thus, one published report describes an immunocompetent 3-year-old boy with meningitis caused by Streptococcus pyogenes without previous evidence of upper respiratory tract infection. A CT of the head showed lesions of the mastoid process and paranasal sinuses, whilst a lumbar puncture revealed cloudy CSF. Empirical intravenous therapy with ceftriaxone and vancomycin led to rapid clinical improvement within the first 24 hours [12].

The clinical case presented here describes a rare GAS-induced meningitis in a 17-year-old immunocompetent patient with a favorable clinical course. The disease developed after a previous upper respiratory tract infection. No established risk factors for GAS meningitis were identified; however, the presence of GAS-associated pansinusitis was likely the primary site of infection.

S. pyogenes, a well-known causative agent of invasive infections, was identified as the etiological agent responsible for the development of intracranial complications, including subdural empyema and encephalitis. The clinical picture and cerebrospinal fluid parameters in our patient with GAS meningitis did not differ specifically from meningitis of other pyogenic etiologies. It is known that the pathogen remains susceptible to third-generation cephalosporins, which are widely used in the empirical therapy of bacterial meningitis due to the increasing penicillin resistance among common pathogens [13]. The patient initially responded positively to therapy with vancomycin and ceftriaxone, which were prescribed based on the results of susceptibility testing of the pathogen in this case to azithromycin, clarithromycin, moxifloxacin and vancomycin. However, a week later, a deterioration in the clinical condition was noted, leading to the replacement of ceftriaxone with meropenem. Subsequently, antibiotic therapy was corrected during the 45 days of treatment, which ensured gradual improvement in clinical, laboratory and instrumental dynamics.

This case expands the available literature and highlights the diagnostic difficulties of bacterial meningitis in adolescents, the possible role of sinusitis in the intracranial spread of infection, and the importance of modern neuroimaging techniques for the early detection of complications and the timely correction of therapeutic tactics.

GAS meningitis is associated with high mortality and morbidity rates. The frequency of complications is likely to exceed that of other forms of bacterial meningitis. The most common complications involve the nervous system — sensorineural hearing loss, hydrocephalus, psychomotor retardation, and motor disorders, and they occur more often in children [11]. In the described case, due to the successful use of clinical, laboratory, and neuroimaging monitoring, it was possible to diagnose the underlying disease and complications at an early stage and adjust antibacterial therapy in a timely manner. This formed the basis for the effectiveness of the treatment, and the child avoided neurosurgical intervention and the formation of severe postinfectious consequences.

Conclusions

Although GAS meningitis is a rare form of invasive infection, it should be considered in the differential diagnosis of meningitis in children and adolescents, especially in the presence of concomitant sinonasal

infection. Given the risk of severe complications, such as subdural empyema, may be successfully managed without neurosurgical intervention when diagnosed and treated promptly.

Abbreviations

CSF
cerebrospinal fluid
CT
Computed Tomography
ESR
erythrocyte sedimentation rate
GAS
group A β-hemolytic streptococcus
MRI
Magnetic Resonance Imaging

Declarations

Acknowledgements

We would like to thank the patient described in this manuscript for giving us the opportunity to follow.

Authors' contributions

OU: designed the project and were involved in patient care, wrote the manuscript.

GL: contributed to editing the manuscript.

OP: assisted with data extraction and analysis.

AT: wrote the manuscript, contributed to editing the manuscript.

YS: assisted with data extraction and analysis.

KS: contributed to editing the manuscript.

All authors read and approved the final manuscript.

Funding

This work received no specific grant from any funding agency.

Data availability

All data generated or analyzed during this study are included in this published article. Additional clinical data are available from the corresponding author upon reasonable request, in accordance with patient confidentiality regulations.

Ethics approval and consent to participate

This study was approved by the Bioethics Committee of Zaporizhzhia State Medical and Pharmaceutical University and conducted in accordance with the Declaration of Helsinki.

Consent for publication

The authors certify that they have obtained all appropriate patient consent forms. The patient and his parents has given consent for their clinical information and images to be reported in the journal. The patient understands that their name and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed. Written informed consent for publication of this case report and any accompanying images was obtained from the patient and his parents. A copy of the written consent is available for review by the Editor-in-Chief of this journal.

Competing interests

The authors declare no competing interests.

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Figures

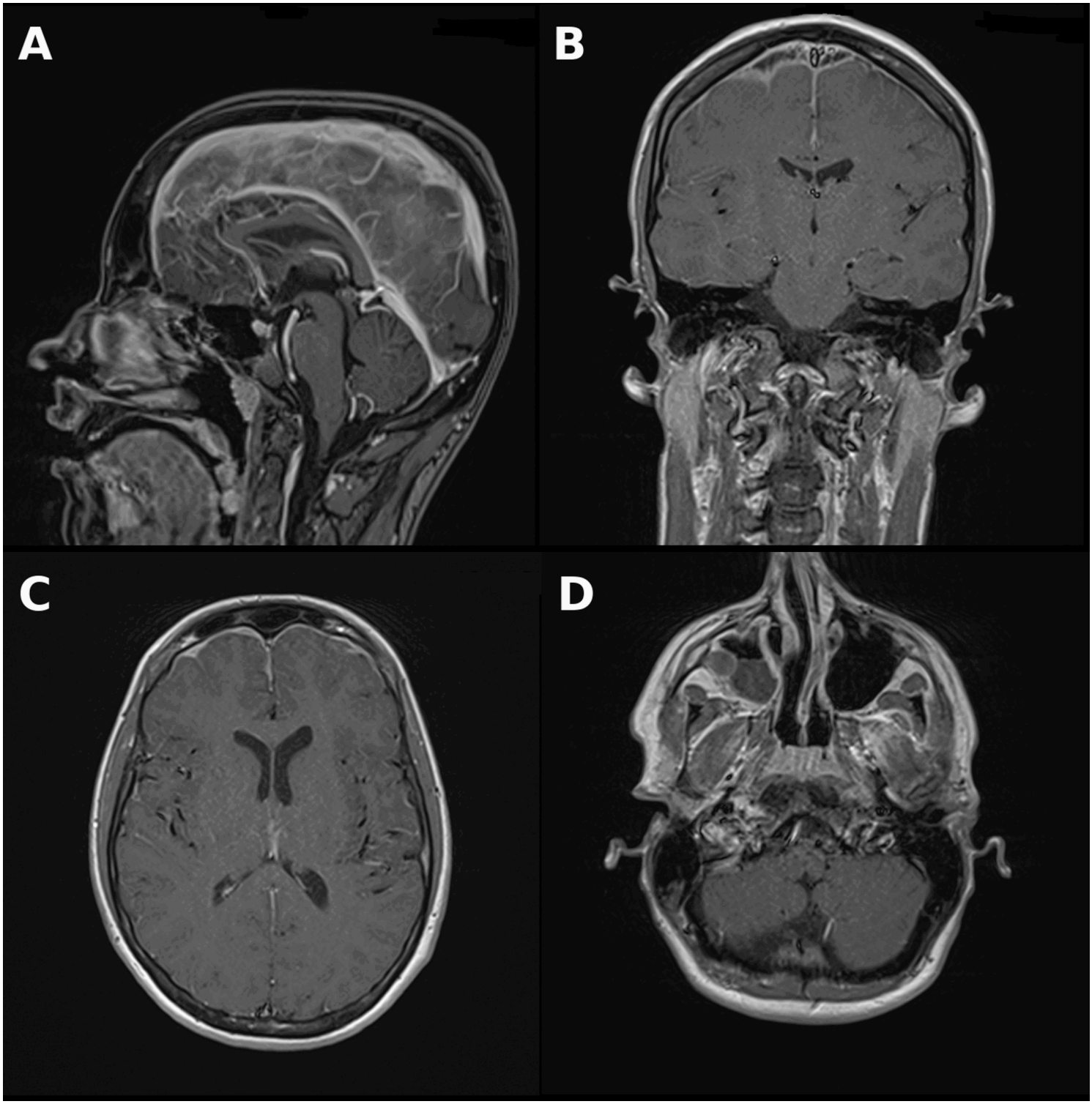


Figure 1

Brain MRI of a 17-year-old patient on day 4 of hospitalization: extensive leptomeningitis involving both cerebral hemispheres (A) with formation of bilateral frontoparietal subdural empyemas (B); reactive bone marrow edema of the parietal bones (C); and signs of inflammatory changes in the right paranasal sinuses (D).

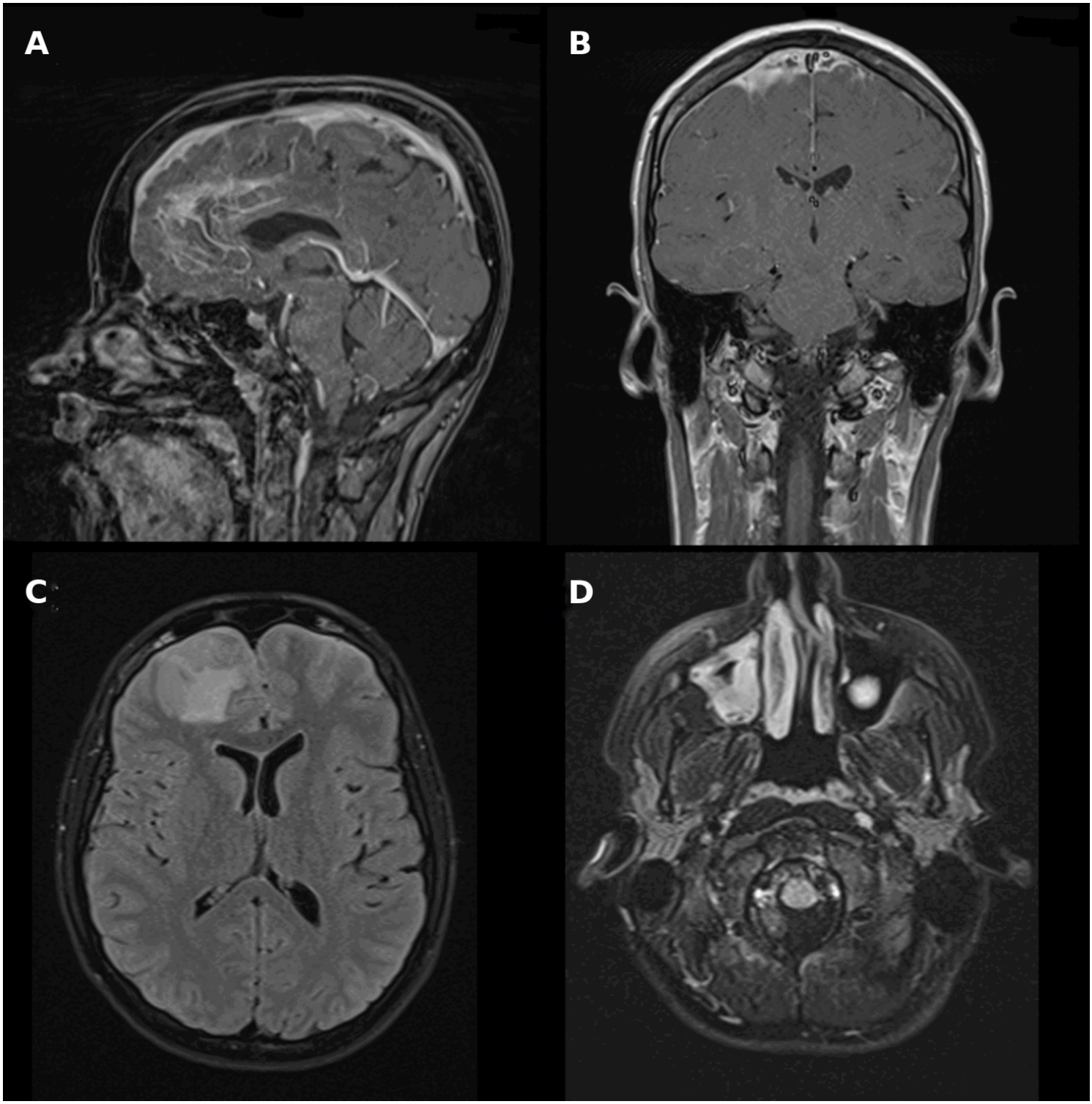


Figure 2

Brain MRI findings on the 10th day of inpatient treatment: leptomeningitis of the cerebral hemispheres (A). Compared with the initial findings, the subdural empyemas (B) are significantly less pronounced, but a focus of inflammation has appeared in the frontal lobes (C); right-sided sinusitis is less pronounced (D).