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CASE REPORT

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Subdural empyema due to mixed infections successfully treated medically: A case report with review literature

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Abstract

Subdural empyema is a rare intracranial infection with an accumulation of purulent material between the dura and arachnoid matter. We report a case of 17 years old presented with an altered conscious level. CSF analysis showed increased WBCs. His situation has improved after treating by acyclovir, ceftriaxone, vancomycin, and dexamethasone.

KEYWORDS

bacterial infection, medical treatment, meningeal irritation, subdural empyema, viral infection

1 | INTRODUCTION

Subdural empyema (SDE) is a collection of pus between the dura and arachnoid layers of the meninges.[1] It is a rare infection of the brain, and it is an almost fatal condition if left untreated, but since using antibiotics, the mortality rate has decreased and now ranges from 14% to 28%.[2,3] In infants, it complicates neonatal meningitis, but in older children, it develops mainly due to ear, sinus infection, or spread from a hematogenous source.[1,3-8] In males, SDE is more frequently seen in males, and it is the most commonly encountered intracranial complication of infection.[4,5] The patient usually presents with fever, sinusitis, and neurological deficits with less frequent symptoms, including headache and seizures with alteration of the level of consciousness.[1,6-10] Laboratory investigations vary from blood to imaging. Computed tomography (CT) and magnetic resonance imaging (MRI) are the most important.[4,11] Also, white blood cell count, erythrocyte sedimentation rate, and C-reactive protein level may be helpful. Imaging is recommended for every patient suspected to have a subdural abscess.

TABLE 1 Summary of the previous case reports[19-53]

Study ID	Sex	Age	Predisposing event	Signs and symptoms	Bilateral or unilateral	Location	Specific location
Şahin 2015	Male	16	Sinusitis	Projectile vomiting, lethargy, fever, and headache	Unilateral	Subdural	Around the right cerebral hemisphere then relapse in the posterior interhemispheric fissure
Yu¨cel 1998	Male	14	Upper air way infection	Deterioration of consciousness, right hemiparesis, edema in the left eyelid and seizures	Unilateral	Subdural	Frontal
Arifianto 2017	Male	17	Allergic rhinitis	Deterioration in consciousness, difficulties in speech, and hemiparesis	Unilateral	Subdural	Interhemispheric and infratentorial
Balfour-Lynn 1997	Female	16		Seizure and visual hallucination	Unilateral	Subdural empyema	Over the right cerebral hemisphere
Banerjee 2010	Male	12	Exposure to an active case of pulmonary tuberculosis	Raised intracranial pressure and fever for 1 month and altered sensorium for 2 days	Unilateral	Subdural empyema	Left frontoparietal and interhemispheric
Derin 2015	Male	16	Dental infection	Dental and facial pain and swelling of the left face	Unilateral	Subdural empyema	Frontal
Borovich 1990	All of them are males	Case 1: 17 Case 2: 35 Case 3: 58	Case 1: purulent meningitis Cases 2 & 3: acute meningitis	Case 1: headaches, abdominal pain, and fever of 1 month's duration Case 2: 1 day of headaches and fever Case 3: otorrhea, fever, and headaches	Cases 1 & 2: unilateral Case 3: Bilateral	All of them are subtentorial collection with marked mass effect	–
Calik 2012	Male	13	Upper air way infection	Fever and cervical micro lymphadenopathy	Unilateral	Subdural empyema	Frontal
Conlon 1996	Case 1	16	–	Fever and left frontal headache then seizures	Unilateral	Subdural empyema	Frontal
	Female	16	Upper air way infection	Photophobia, frontal headache and periorbital swelling	Unilateral	Cerebritis	Frontal
Dolan 1995	Male	16	Suspected sinusitis	Altered mental status and slurring of speech	Unilateral	Subdural empyema	Frontal
Dunn 2013	Male	14	Migraine headaches and acute sinusitis	Vomiting and nausea	Unilateral	Epidural and subdural empyema	Frontopaetial
Harris 1987	Male	12	Sinusitis	Fever, lethargy and monoplegia	Unilateral	Subdural empyema	–
Heilbronn 1984	Male	13	Pansinusitis	Frontal headache early then the patient developed neck stiffness	Unilateral	Subdural	Frontal and temporal
	Female	12	Pharyngitis	Fever, neck stiffness	Unilateral	Subdural empyema	Lateral ventricles
Holland 2012	Male	15	Sinusitis	Headache and low-grade fever then motor disability	Unilateral	Subdural empyema	Right frontal sinus
Jones 1997	Female	14	Previous infection of mixed coliforms and Enterococcus	Deterioration of consciousness and bilateral abducent nerve palsy	Unilateral	Sub-tentorial empyema	Left cerebellar hemisphere

Medline Shift	Intra-axial component (yes/no)	CNS infection (causative organism)	Follow-up period	Intervention used	Outcome
Present	None	*Streptococcus constellatus*	2 months	Frontoparietal craniotomy	Hemiparesis of the patient improved gradually and SDE regressed completely after ampicillin treatment
Absence	None	*Streptococcus pneumococcus*	2 weeks	Craniectomy	Patient lost vision then he responded for treatment and was released from hospital
Present	None	*Staphylococcus epidermidis*	4 weeks	Conservative therapy then craniotomy	All the symptoms resolved; the only remaining symptom was limited extraocular muscle movement
Absence	Yes	*Burkholderia cepacia*	1 year	Craniectomy	Initial recovery then deterioration and obliterative bronchitis of the lung although the use of antibiotics
Absence	No	Acid-fast bacilli of TB	18 months	Craniectomy	Full recovery and no recurrence
Absence	No	*Streptococcus viridans*	8 weeks	Sinus drainage for pansinusitis and Empiric therapy	Recovery and patient discharge
All cases: Absence	All cases: No	Case 1: *Pneumococcus* and *Proteus*. Cases 2 & 3: None mentioned	–	Case 1: penicillin and gentamicin then left suboccipital craniectomy Case 2: Antibiotics then suboccipital craniectomy Case 3: penicillin and chloramphenicol then external ventricular drainage, drainage of the subtentorial pus, and a bilateral mastoidectomy	Cases 1 & 2: Recovery and patient discharge Case 3: The patient died 24 h after surgery
Absence	No		4 weeks	Craniotomy and sinusotomy	Recovery and patient discharge
Absence	No		NR	Craniotomy	Recovery and patient discharge
Absence	No	Pansinusitis by B hemolytic *Streptococcus* group A	1 week	Pus aspiration from sinus	Recovery and patient discharge
Absence	No	NR	NR	Craniotomy and twist drill ventriculostomy	Recovery and patient discharge
Present	No	Threatening	6 weeks	Bifrontal craniotomy, physical and speech therapies in follow-up	Full recovery and no recurrence
Absence	No	NR	NR	Craniotomy	Recovery and patient discharge
Absence	No	Pansinusitis by B hemolytic *Streptococcus* group A	NR	Exploration surgery and resection of necrotized tissue	Patient death
Absence	No		NR	Craniectomy	Recovery and patient discharge with anticonvulsant therapy
Present	No	*Pneumococcus*	6 months	Craniotomy, ventricular drain, speech, and physical therapy	Postsurgical facial droop and unequal pupil dilation, after recovery the patient was discharged with residual left-sided weakness
Absence	No	*Enterococcus faecalis*	4 weeks	Craniectomy and radical mastoidectomy	Full recovery and no recurrence

(Continues)

TABLE 1 (Continued)

Study ID	Sex	Age	Predisposing event	Signs and symptoms	Bilateral or unilateral	Location	Specific location
Kageyama 2000	Male	18		Neurological deterioration, mild fever and vomiting	Unilateral	Subdural empyema	Paranasal sinuses and convexity
Kuczkowski 2005	Male	14	Purulent rhinorrhea and upper respiratory tract infection	Headache, nausea, vomiting	Bilateral	Subdural empyema	Frontal brain lobes
	Male	12	Purulent rhinorrhea and upper respiratory tract infection	Headache, periorbital swelling and meningitis	Unilateral	Subdural empyema	Frontal sinuses
Kwangong 2002	All are males	7 patients (9–14)	Sinusitis	Headache, fever, motor deficit, seizures, and altered mental status	Unilateral	Subdural empyema	Frontal sinusitis
Lefebvre 2009	Male	15	Sinusitis	Headache and hemiparesis	Unilateral	Subdural empyema	Subdural and maxillary sinus
Manjila 2017	Male	14	Sinusitis	Epistaxis due to suspected carotid artery damage	Unilateral	Subdural empyema and cavernous sinus pseudo aneurism	Frontal and temporal regions
Martins 2014	Male	18	Sinusitis	Dysarthria, fever and purulent rhinorrhea	Unilateral	Subdural empyema	Maxillary sinus and frontal sinus
Millar 1996	Male	14	Flu-like illness	Hemiparesis, headache and fever	Unilateral	Subdural empyema	Right frontal
Mitsuoka 1995	Male	14	Retrobulbar pain and eye swelling	Seizure and loss of consciousness	Unilateral	Subdural and interhemispheric empyema	Falx
Morgan 1995	Male	17		Dysarthria, headache and neck stiffness and decreased sensation	Bilateral		Basal cisterns and subdural
	Male	15	Chronic otitis	Bilateral papilledema, nystagmus, ataxia, and photophobia	Unilateral	Subdural empyema	–
	Male	17		Postnasal discharge, fever and retroorbital pain, later he developed limb weakness	Unilateral	Subdural empyema	–
Nica 2011	Male	15	Meningio-encephalitis	Drowsiness, cervical pain and headache	Unilateral	Subdural empyema	Fronto-temporo-parietal
Ong 2002	Male	13		Fever, drowsiness, headaches, and nausea later he developed unequal pupils and a suspected hemorrhagic infarct on CT scan	Unilateral	Subdural empyema	–
Pattisapu 2008	Male	11	Otitis media and mastoiditis	Nuchal rigidity, headache and lethargy	Bilateral	Subdural empyema	Subtentorial
	Male	11	meningitis	Seizures, nuchal rigidity and decorticate posturing	Bilateral	Subdural empyema	Subfrontal, parafalcine
	Female	13	Ethmoiditis and frontal osteomyelitis	Facial swelling, orbital cellulitis and hemiparesis	Bilateral	Subdural empyema	Parafalcine
Sengul 2009	Male	15	Left otitis media and meningitis	Fever, headache, earache, and neck stiffness	Unilateral	Subdural empyema	–

Medline Shift	Intra-axial component (yes/no)	CNS infection (causative organism)	Follow-up period	Intervention used	Outcome
Absence	No	*Streptococcus milleri*	2 weeks	Burr holes drainage and barbiturates	Recovery and patient discharge
Absence	No	β-hemolytic group C *Streptococcus*		Craniotomy	Full recovery and no recurrence
Absence	No	Negative		Craniotomy	Death 13 days after surgery
Absence	No			Craniotomies and endoscopic sinus surgeries	5 complete recovery and 1 hydrocephalus
Absence	No	*Streptococcus constellatus*	6 months	Craniotomy	Recurrent interhemispheric empyema then total recovery
Absence	No	Methicillin-sensitive *Staphylococcus aureus*		Craniotomy and arterial resection and reconstruction	Recovery and patient discharge
Absence	No	Alpha hemolytic streptococci	3 months	Craniotomy and maxillary antrostomy	Recovery and improvement of dysarthria
Absence	No		2 weeks	Craniotomy	Death 3 days after surgery
Absence	NO	*Streptococcus* species	4 weeks	Craniotomy	Full recovery and no recurrence
Absence	NO	Anaerobic hemolytic streptococci		3 drainage operations yet he developed meningitis and his condition deteriorated	Death after complications
Absence	NO	Nonhemolytic streptococci		Craniectomy and radical mastoidectomy	recovery and discharge
Absence	NO	Beta hemolytic streptococci of Lancefield group C	4 weeks	2 craniotomies	Full recovery and no recurrence
Absence	NO	*Fusobacterium varium*, *Fusobacterium mortiferum* and *Propionibacterium propionicum*	1.5 years	Craniectomy	Full recovery after physical therapy
Absence	NO	*Streptococcus constellatus*		Craniectomy	Recovery and patient discharge
Absence	No	*Proteus*, *E. coli* and *Bacteroides*	48 months	Burrhole catheter drainage	Recovery and patient discharge
Absence	No	*Salmonella* Type C	45 months	Burrhole catheter drainage	Recovery and patient discharge
Absence	No	Group D *Streptococcus*, *Bacteroides melaningenicus*	38 months	Craniotomy and ethmoidectomy	Recovery and patient discharge
Absence	No	No organisms on culture	2 years	Craniectomy	Recovery and patient discharge

(Continues)

TABLE 1 (Continued)

Study ID	Sex	Age	Predisposing event	Signs and symptoms	Bilateral or unilateral	Location	Specific location
Per 2010	Male	15		Facial swelling and fever later, he developed hemiparesis and seizures	Unilateral	Epidural and subdural empyema	Frontal
Salunke 2010	4 males and 2 females	6 patients (12–19)		All presented with headache, vomiting, and fever only one patient had advance seizures and hemiparesis	Unilateral	Subdural empyema	Front parietal subdural
Tankhiwale 2014	Male	14		High grade intermittent fever, altered sensorium, neck stiffness, and seizures	Bilateral	Subdural empyema	Subdural
Teelin 2017	Male	14	Sinusitis	Seizures, headache, intermittent low-grade fever	Unilateral	Subdural empyema	Frontal
Teng 2012	Male	17	Sore throat	Fever, nuchal rigidity and drowsiness	Unilateral	Epidural and subdural empyema	Frontoparietal subdural and medial-frontal epidural
Waseem 2008	Male	14	Upper air way infection	Fever and headaches, later he developed deep dull ache and facial heaviness	Unilateral	Subdural empyema	Frontal and ethmoid sinuses
Westhout 2007	Male	16	Sore throat	Dyspnea, neck pain, anorexia and oliguria	Bilateral	Subdural empyema	–

In some cases, when the diagnosis by CT and MRI is unclear, hollow screws have a diagnostic value.[12] Road spectrum antibiotics are usually the first-line management, and they may be enough to control the infection.[13-15] However, the surgical intervention must be considered if the antibiotics fail to maintain or other surgery indications.[16,17] The most common surgical procedures are craniotomy and burr holes.[13,14] If the surgical intervention has been done within 72 h, the chance for disability is 10% compared to 70% when done after 72 h.[18]

Because of its rarity, many doctors may not have seen a case in recent years. The topic should be re-visited to remind them to be aware of it. Also, it is difficult to distinguish from meningitis; hence, the attending clinician must have a high suspicion index.

In this report, we presented a SDE case successfully treated by medical treatment in our hospital. Also, we systematically summarized the previously published case reports about SDE.

2 | LITERATURE REVIEW

We searched for published case reports in four electronic databases: PubMed, Scopus, Web of Science, and Cochrane Central Register of Controlled Trials (CENTRAL) in October 2020 using the following query: ("Empyema, Subdural"[Mesh]). We included all English case reports about SDE in adolescent patients (10–19 years).

Since 1990, approximately 35 studies with 53 patients have reported similar cases in this age group; almost all were males (86.7%). The observed pattern of predisposing events is sinusitis, otitis media, or an upper airway infection. Patients have usually suffered from fever, headache, and drowsiness. The neurological manifestations started with nuchal rigidity (17% of cases), hemiplegia (11.3% of cases), or seizures (18.8% of cases).

Details of each case and the organism isolated from the culture and the outcome are shown in Table 1.

3 | CASE REPORT

A 17-year-old male patient was referred to our hospital. He had no history of co-morbid illnesses. At first sight, he seemed distracted, and an altered conscious level was noted. By history, 7 days ago, the condition was started with a headache and low-grade fever without apparent septic focus; no tonsillitis or upper respiratory tract infection. The patient came to our hospital with his family member (from whom the history had been taken). They complained that the patient had a fever, which was not improved by analgesics associated with malaise and disturbing consciousness level in drowsiness and confusion; the patient was inattentive and disoriented to time, place, and persons. On examination, the patient was feverish (38.5), drowsy, confused, and had no focal neurological deficit with positive meningeal irritation signs, neck

Medline Shift	Intra-axial component (yes/no)	CNS infection (causative organism)	Follow-up period	Intervention used	Outcome
Absence	Yes	*Pasteurella multocida*	4.5 years	Empyema evacuation	Recovery and the patient is kept on antiepileptic therapy
Absence	No	4 Negative cultures -1 MRSA -1 *E. coli*	3–60 months	Craniotomy	Recovery and discharge
Absence	No	*Mycobacterium fortuitum*	6 weeks	Craniotomy	Full recovery and no recurrence
Absence	No	*Streptococcus anginosus*		Craniotomy	Full recovery and no recurrence
Absence	No	*Fusobacterium* species		Craniotomy	Full recovery and no recurrence
Absence	No	Group F streptococci	2 months	Craniotomy	Recovery and discharge
Absence	No	*Streptococcus* species	7 weeks	Conservative treatment after tonsillectomy	Recovery and discharge

stiffness, positive kerning's, and stretch leg signs. CT brain at once showed mild diffuse brain edema of the right cerebral hemisphere with a suspected thin rim of overlying extra-axial fluid collection (Figure 1). We asked for a lumbar puncture (after taking consent from the family) to obtain a CSF sample for analysis. Septic screen samples, urine analysis and cultures, nasal swab, axillary culture, throat culture, blood culture, and sputum culture were also withdrawn. Routine laboratories were withdrawn as well, including complete blood count with differential, kidney and liver functions, and electrolyte levels.

Few days later, the results of CSF analysis showed that CSF was clear colorless fluid, RBCs 400 cells/cmm, WBCs 66 cells/cmm (neutrophils 30%, lymphocytes 65%, mononuclear cells 5%), CSF glucose was 4.8 mmol/L which is high (normal range 2.2–3.9 mmol/L), CSF protein was 52.7 mg/dl which is also high (normal range 15–45 mg/dl). Also, CSF cultures were negative for any bacterial growth, including gram bacteria and acid-fast bacilli. Acid-fast bacilli PCR is also negative.

Septic screen results also were negative for any bacterial growth. The rest of the tests were normal except for an increased W.B.C.s count of 14 $\times 10^3$ with increased neutrophils 87.9.

Low-grade fever at first, high glucose level, and predominance of lymphocytes in CSF are evidence of viral infection. In addition, mucocele and the presence of sinusitis are bacterial infections, so a treatment that covers possible causes of C.N.S. infection was initiated: acyclovir (10 mg/kg IV ter in die [tid]; three times a day), ceftriaxone (2 g IV bis in die [bid]; twice a day), vancomycin (750 mg IV bid), and dexamethasone (4 mg IV quarter in die [qid]; four times a day).

The following day, an MRI brain with contrast was conducted and showed mild diffuse thickening of the pachy/leptomeninges overlying the right cerebral hemisphere with mild intervening fluid collection seen eliciting low signal on t1 and high signal on t2-weighted images with evidence of diffusion restriction, features suggestive right-side meningitis with mild SDE. Evidence of right-sided mild mass effects that was manifested by effacement of the underlying cortical sulci with mild compression on the right lateral ventricle. In addition to that, there was obliteration and mildly expansion of the frontal sinus, showing a high signal on both t1-, and t2-weighted images, likely representing mucocele formation. Also, the sphenoid, right ethmoid sinuses, and suitable mastoid air cells have been destroyed (Figure 2).

At the end of the second day after admission, the patient developed serial attacks of generalized tonic colonic fits, controlled by giving loading phenytoin (15 mg/kg); after that, we kept him on levetiracetam (500 mg P.O. B.I.D.). Also, E.E.G. was done, which showed slowness in activity (Figure 3). The patient's condition improved on the 5th day regarding consciousness level, and no more fits had occurred. The patient was continued on the same treatment measures. A follow-up MRI. brain with contrast was done after 1 week (Figure 4) and

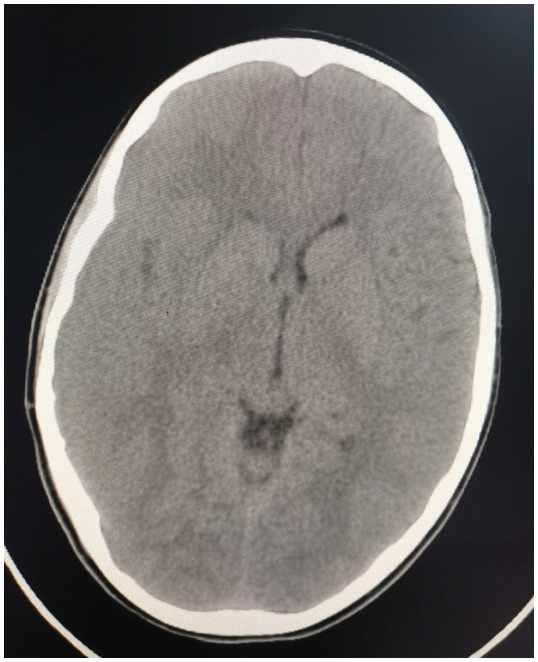

FIGURE 1 CT brain at presentation: mild diffuse brain edema of the right cerebral hemisphere

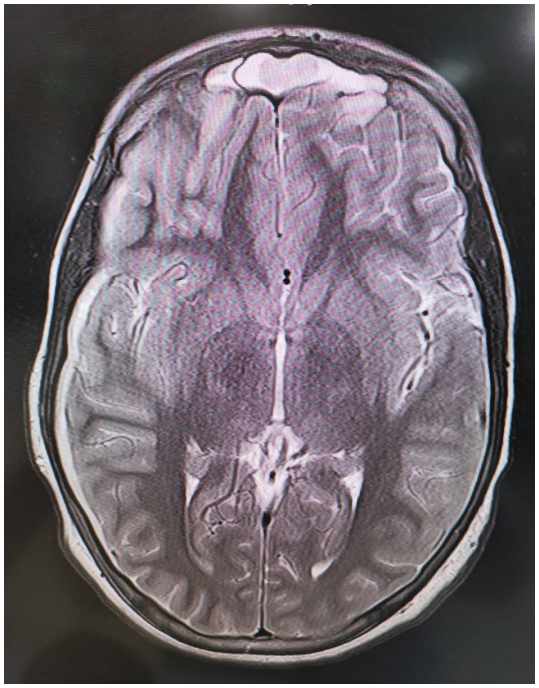

FIGURE 2 MRI brain with contrast at the next morning: Mild diffuse thickening of the pachy/leptomeninges over lying the right cerebral hemisphere with mild intervening fluid collection

3 weeks (Figure 5), which showed significant regression of the meningeal thickening and enhancement for the right SDE.

The patient was discharged with marked improvement up to his normal state with no complaints.

4 | DISCUSSION

This case report presents a patient with SDE resulting from a mixed bacterial and viral infection. The patient suffered from sinusitis 7 days before our investigation. The CSF analysis showed an increasing number of WBCs (66 cells/cmm) and 30% neutrophils. The CT scan showed mild diffuse brain edema of the right cerebral hemisphere with suspected mucocele formation, which is considered evidence of bacterial infection. Also, CSF analysis showed an increase in the number of lymphocytes 65% and glucose 4.8 mmol/L, which is evidence of viral infection. Our case showed a thin rim in CT and no significant midline shift in MRI, so it is considered a mild case. Although surgery is the first line in the treatment of SDE, there is a widely unutilized option to use antibiotics in mild cases.[18,54] So we treated our patient medically with acyclovir (10 mg/kg IV tid) for viral infection; ceftriaxone (2 g IV bid) and vancomycin (750 mg IV bid) for bacterial infection and dexamethasone (4 mg qid). The treatment was effective, and the patient had recovered with no severe side effects or disability.

What makes this case unique is a mixed infection; the patient was also treated medically, while a limitation was no PCR analysis for causative organisms. The case was diagnosed as SDE depending on the clinical history (fever, disturbed conscious level, meningeal irritation signs, fits, and preceding infection), CSF findings (which showed the proof of mixed infection), and MRI brain findings. Also, there was evidence of EEG changes in the form of slowness activity, which is going with Mauser H.W et al. They found multiple EEG changes that may occur with SDE cases, including diffuse slowness.[54] Thus, diagnosis depends only on clinical history, signs, laboratories, EEG, and radiology findings.

Ruth et al. concluded that a nonsurgical strategy might be considered for patients with a good clinical condition with a minor shift from the midline on radiology results.[19,55] For 4 weeks, Musa et al. reported evidence of pre-surgical treatment with I.V chloramphenicol and metronidazole. They increased a Glasgow coma scale from 8/15 to 15/15 with no seizures.[21] SDE had reported getting negative in culture test; a case series by Madhugiri et al. consisting of 27 patients with a mean age of 10 years reported that 26% of patients get negative in culture test.[20]

Based on our case, physicians should consider the treatment of viral and bacterial infections in similar circumstances. Medical treatment of mild SDE patients can be effective and safe. Future research is needed to investigate the merits and limitations of using medical therapy alone in SDE with mild and moderate cases. In conclusion, as there were multiple conflicts in differentiation

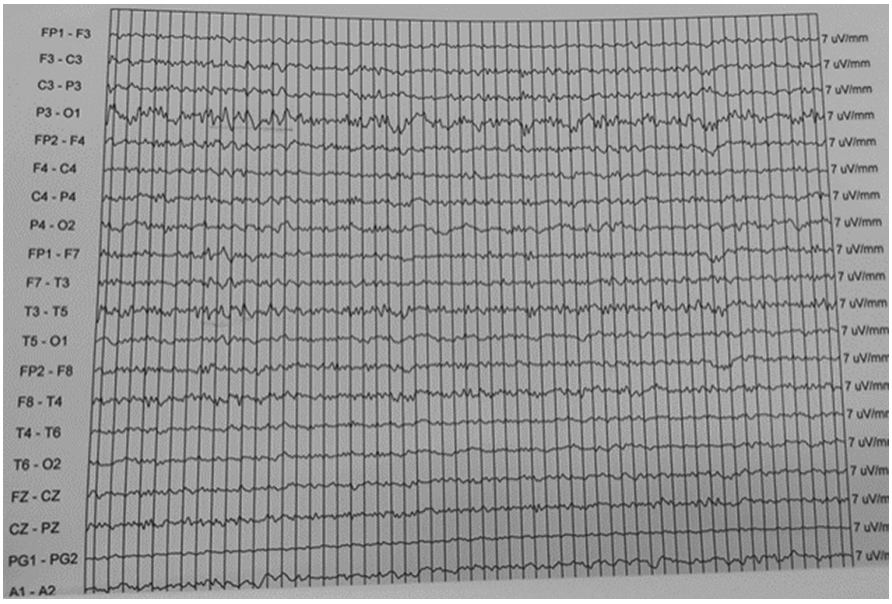

FIGURE 3 EEG sheet which showed slowness activity

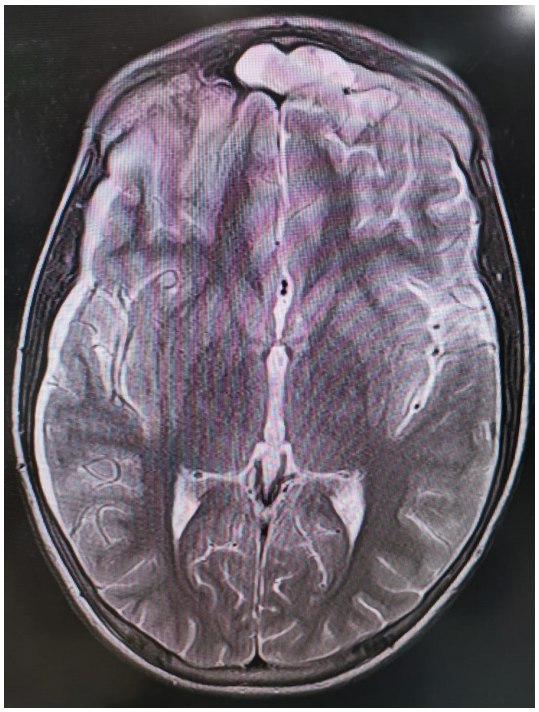

FIGURE 4 MRI brain with contrast during the follow up after 1 week

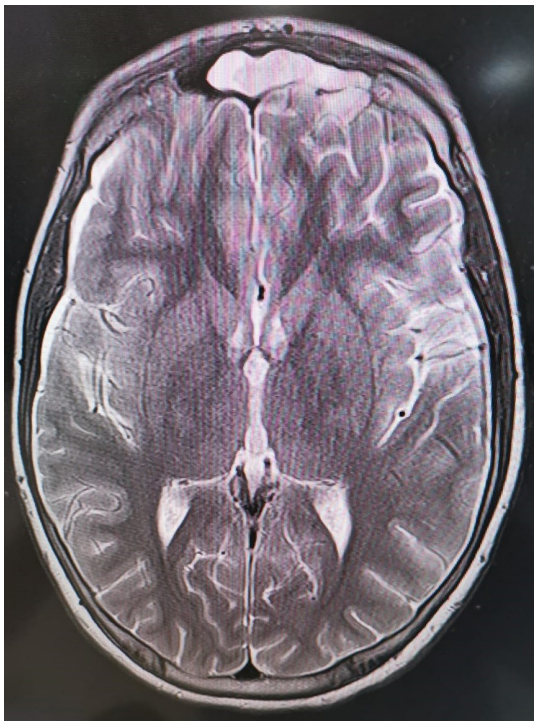

FIGURE 5 MRI brain with contrast during the follow up after 3 weeks

between SDE and meningitis, all attending doctors must suspect it. Start medical treatment as soon as possible for all suspected cases depending on the clinical, radiological, and laboratory findings. According to the case degree, early intervention in those cases, whether medical or surgical, can improve patient outcomes and good prognosis. In spite, our case showed marked improvement only on using medical treatments. Multiple researches should be conducted for clarification and putting criteria for either medical or surgical therapies for SDE patients.

AUTHOR CONTRIBUTIONS

All authors have contributed in writing and reviewing the manuscript.

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N/A.

CONFLICT OF INTEREST

There is no conflict of interest.

DATA AVAILABILITY STATEMENT

None.

ETHICAL APPROVAL

Consent to case study report given by Nassau University Medical Centre, NY.

CONSENT

We obtained all appropriate patient consent forms. In the form, the patient has given his consent for his images and other clinical information to be reported in the journal. The patient knew that his name and initials would not be published, and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed. Written informed consent was obtained from the patient to publish this report in accordance with the journal's patient consent policy.

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REFERENCES

1. Gormley WB, del Busto R, Saravolatz LD, et al. Cranial and intracranial bacterial infections. *Neurol Surg*. 1996;5:3191-3322.
2. Hlavin ML, Kaminski HJ, Fenstermaker RA, White RJ. Intracranial suppuration: a modern decade of postoperative subdural empyema and epidural abscess. *Neurosurgery*. 1994;34(6):974-981.
3. Nathoo N, Nadvi SS, Van Dellen JR, Gouws E. Intracranial subdural empyemas in the era of computed tomography: a review of 699 cases. *Neurosurgery*. 1999;44(3):529-536.
4. Rich PM, Deasy NP, Jarosz JM. Intracranial dural empyema. *Br J Radiol*. 2000;73(876):1329-1336.
5. Demaerel PAJ. Barkovich: pediatric neuroimaging, 3rd edn. *Eur Radiol*. 2001;11(11):2347.
6. Quraishi H, Zevallos JP. Subdural empyema as a complication of sinusitis in the pediatric population. *Int J Pediatr Otorhinolaryngol*. 2006;70(9):1581-1586.
7. Tewari MK, Sharma RR, Shiv VK, Lad SD. Spectrum of intracranial subdural empyemas in a series of 45 patients: current surgical options and outcome. *Neurol India*. 2004;52(3):346-349.
8. Greenlee JE. Subdural empyema. *Curr Treat Options Neurol*. 2003;5(1):13-22.
9. Adame N, Hedlund G, Byington CL. Sinogenic intracranial empyema in children. *Pediatrics*. 2005;116(3):e461-e467.
10. Yilmaz N, Kiymaz N, Yilmaz C, et al. Surgical treatment outcome of subdural empyema: a clinical study. *Pediatr Neurosurg*. 2006;42(5):293-298.
11. Weingarten K, Zimmerman RD, Becker RD, Heier LA, Haimes AB, Deck MDF. Subdural and epidural empyemas: MR imaging. *Am J Roentgenol*. 1989;152(3):615-621.
12. Aldinger FA, Shiban E, Gempt J, Meyer B, Kreutzer J, Krieg SM. Hollow screws: a diagnostic tool for intracranial empyema. *Acta Neurochir*. 2013;155(2):373-377.
13. Feuerman T, Wackym PA, Gade GF, Dubrow T. Craniotomy improves outcome in subdural empyema. *Surg Neurol*. 1989;32(2):105-110.
14. Glass RL. Osteoplastic flap method in the treatment of subdural abscess. *J Neurosurg*. 1947;4(4):391-393.
15. Mauser HW, Van Houwelingen HC, Tulleken CAF. Factors affecting the outcome in subdural empyema. *J Neurol Neurosurg Psychiatry*. 1987;50(9):1136-1141.
16. Mauser HW, Ravijst RAP, Elderson A, van Gijn J, Tulleken CA. Nonsurgical treatment of subdural empyema. Case report. *J Neurosurg*. 1985;63(1):128-130.
17. Leys D, Destee A, Petit H, Warot P. Management of subdural intracranial empyemas should not always require surgery. *J Neurol Neurosurg Psychiatry*. 1986;49(6):635-639.
18. Renaudin JW, Frazee J. Subdural empyema - importance of early diagnosis. *Neurosurgery*. 1980;7(5):477-479.
19. Yücel ÖT, Öğretmenoğlu O. Subdural empyema and blindness due to cavernous sinus thrombosis in acute frontal sinusitis. *Int J Pediatr Otorhinolaryngol*. 1998;46(1–2):121-125.
20. Arifianto MR, Ma'Ruf AZ, Ibrahim A, Bajamal AH. Interhemispheric and infratentorial subdural empyema with preseptal cellulitis as complications of sinusitis: a case report. *Pediatr Neurosurg*. 2018;53(2):128-133.
21. Balfour-Lynn LM. Subdural empyema due to *Burkholderia cepacia*: an unusual complication after lung transplantation for cystic fibrosis. *J R Soc Med*. 1997;90(31):59-64.
22. Banerjee AD, Pandey P, Ambekar S, Chandramouli BA. Pediatric intracranial subdural empyema caused by *Mycobacterium tuberculosis* – a case report and review of literature. *Childs Nerv Syst*. 2010;26(8):1117-1120.
23. Derin S, Sahan M, Hazer DB, Sahan L. Subdural empyema and unilateral pansinusitis due to a tooth infection. *BMJ Case Rep*. 2015;2015:2014-2016.
24. Borovich B, Johnston E, Spagnuolo E. Infratentorial subdural empyema: clinical and computerized tomography findings. Report of three cases. *J Neurosurg*. 1990;72(2):299-301.
25. Calik M, Iscan A, Abuhandan M, Yetkin I, Bozkuş F, Torun MF. Masked subdural empyema secondary to frontal sinusitis. *Am J Emerg Med*. 2012;30(8):1-4.
26. Conlon BJ, Curran A, Timon CV. Pitfalls in the determination of intracranial spread of complicated suppurative sinusitis. *J Laryngol Otol*. 1996;110(7):673-675.
27. Dolan RW, Chowdhury K. Diagnosis and treatment of intracranial complications of paranasal sinus infections. *J Oral Maxillofac Surg*. 1995;53(9):1080-1087.
28. Dunn B, McCalla C, Hiestand B, O'Brien MC. The pediatric headache that would not go away. *Pediatr Emerg Care*. 2013;29(12):1283-1286.
29. Harris LF, Haws FP, Triplett JN Jr, Maccubbin DA. Subdural empyema and edpidural abscess: recent expereince in a community hospital. *Sothern medical ournal*. 1987;80(10):125-8. doi:10.1097/00007610000-00014
30. Heilbronn YD, Tovi F, Hirsch M, Ronen J. Subdural empyema of sinus origin in children. *Int J Pediatr Otorhinolaryngol*. 1984;6(C):205-211.

31. Holland AA, Morriss M, Glasier PC, Stavinoha PL. Complicated subdural empyema in an adolescent. *Arch Clin Neuropsychol*. 2013;28(1):81-91.
32. Jones BL, Wilcox MH. Subdural empyema due to *Enterococcus faecalis*. *Scand J Infect Dis*. 1997;29(6):627-628.
33. Kageyama G, Park KC, Yoshimine Y, Yokota J. Extensive subdural empyema treated with drainage and barbiturate therapy under intracranial pressure monitoring: case report. *Neurol Res*. 2000;22(6):601-604.
34. Kuczkowski J, Narozny W, Mikaszewski B, Stankiewicz C. Suppurative complications of frontal sinusitis in children. *Clin Pediatr (Phila)*. 2005;44(8):675-682.
35. Kwang Ong Y, Tan HKK. Suppurative intracranial complications of sinusitis in children. *Int J Pediatr Otorhinolaryngol*. 2002;66(1):49-54.
36. Lefebvre L, Metellus P, Dufour H, Bruder N. Linezolid for treatment of subdural empyema due to streptococcus: case reports. *Surg Neurol*. 2009;71(1):89-91. doi:10.1016/j.surneu.2007.06.083
37. Manjila S, Singh G, Ndubuizu O, Jones Z, Hsu DP, Cohen AR. Endovascular plug for internal carotid artery occlusion in the management of a cavernous pseudoaneurysm with bifrontal subdural empyema: technical note. *J Neurosurg Pediatr*. 2017;20(3):239-246.
38. Millar JS, Choksey MS. Case of the month: size is not important. *Br J Radiol*. 1996;69(817):87-88.
39. Mitsuoka H, Tsunoda A, Mori K, Tajima A, Maeda M. Hypertrophic anterior falx artery associated with interhemispheric subdural empyema: case report. *Neurol Med Chir (Tokyo)*. 1995;35(11):830-832.
40. Morgan DW, Williams B. Posterior fossa subdural empyema. *Brain*. 1985;108(4):983-992.
41. Nica DA, Moroti-Constantinescu R, Copaciu R, Nica M. Multidisciplinary management and outcome in subdural empyema – a case report. *Chirurgia (Bucur)*. 2011;108(5):673-676.
42. Pattisapu JV, Parent AD. Subdural empyemas in children. *Pediatr Neurosurg*. 1987;13(5):251-254.
43. Şengül G. İnfratentoryal subdural ampiyem. *Turk Neurosurg*. 2009;19(2):200-202.
44. Salunke PS, Malik V, Kovai P, Mukherjee KK. Falcotentorial subdural empyema: analysis of 10 cases. *Acta Neurochir*. 2011;153(1):164-169.
45. Tankhiwale SS, Katkar VJ. Subdural empyma due to *Mycobacterium fortuitum* in a non-HIV patient. *Indian J Med Microbiol*. 2014;32(4):446-448.
46. Teelin K. New-onset seizures in a 14-year-old boy. 2017.
47. Teng HW, Chen CY, Chen HC, Chung WT, Lee WS. Fusobacterium septicemia complicated by cerebral subdural and epidural empyemas: a rare case of Lemierre syndrome. *J Emerg Med*. 2012;43(4):671-673. doi:10.1016/j.jemermed.2010.04.033
48. Waseem M, Khan S, Bomann S. Subdural empyema complicating sinusitis. *J Emerg Med*. 2008;35(3):277-281.
49. Arifianto MR, Ma'ruf AZ, Ibrahim A, Bajamal AH. Interhemispheric and Infratentorial Subdural Empyema with Preseptal Cellulitis as Complications of Sinusitis: A Case Report. *Pediatr Neurosurg.*. 2018;53(2):128-133.
50. Banerjee AV, Duflo E, Glennerster R. Kothari D. Improving immunisation coverage in rural India: clustered randomised controlled evaluation of immunisation campaigns with and without incentives. *BMJ*. 2010;340:c2220.
51. Martines F, Salvago P, Ferrara S, Mucia M, Gambino A, Sireci F. Parietal subdural empyema as complication of acute odontogenic sinusitis: a case report. *J Med Case Rep.*. 2014;8(1):1-7.
52. Per H, Kumandaş S, Gümüş H, Öztürk MK, Çoşkun A. Meningitis and subgaleal, subdural, epidural empyema due to Pasteurella multocida. *J Emerg Med.*. 2010;39(1):35-38.
53. Metaxas EK, Condilis N, Tzatzadakis N, Kyriazis H, Kalantzi N, Gerazounis MI. Therapy of the empyema thoracis. Why not thoracostoma?. *Ann Ital Chir.* 2007;78(4):307-310.
54. Mauser H, Van Huffelen A, Tulleken CA. The EEG in the diagnosis of subdural empyema. *Electroencephalogr Clin Neurophysiol*. 1986;64(6):511-516.
55. Şahin S, Yazar U, Cansu A, Kul S, Kaya S, Özdoğan EB. Is sinusitis innocent?–unilateral subdural empyema in an immunocompetent child. *Indian J Pediatr*. 2015;82(11):1061-1064.

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