

Complete recovery of interhemispheric subdural empyema extending to cerebellar tentorium treated with antibiotics as unimodal therapy: a case report and controversial literature review



Fadia Hasna Thohari^{1*}, Paulus Sugianto¹, Djohan Ardiansyah¹

ABSTRACT

Background: Intracranial subdural empyema, although rare, represents an extreme medical and neurosurgical emergency. Multiple burr holes or a craniotomy for drainage and antibiotics are the treatment of choice. This case study aims to evaluate the complete recovery of interhemispheric subdural empyema extending to cerebellar tentorium treated with antibiotics as unimodal therapy.

Case Presentation: We present a case of a 40-year-old male with severe headache, a decrease of consciousness GCS E3V1M5, generalized onset tonic-clonic seizure, right abducens palsy, and right hemiparesis. Interhemispheric subdural empyema extending to cerebellar tentorium with associated intracranial abscess was seen from brain magnetic resonance imaging (MRI). Antibiotics were administered without surgical intervention due to the patient's family rejection. The patient regained full consciousness within 1 week and complete neurological function after 4 weeks of continuous use of antibiotics. The patient was discharged, and his recovery was uneventful on subsequent follow-up.

Conclusion: The use of antibiotics as monotherapy in subdural empyema is controversial, as it is widely accepted that surgery must be initiated as soon as possible in this pathology. It is indicated in small portions of cases without major neurological deficits or in particular conditions where surgery could not be performed. Still, more recent studies found it justifiable in patients with documented initial good responses. This case report highlights the complete recovery and the clinical outcome of antibiotics as monotherapy for subdural empyema.

Keywords: Antibiotic Monotherapy, Complete Recovery, Interhemispheric Subdural Empyema.

Cite This Article: Thohari, F.H., Sugianto, P., Ardiansyah, D. 2023. Complete recovery of interhemispheric subdural empyema extending to cerebellar tentorium treated with antibiotics as unimodal therapy: a case report and controversial literature review. *Bali Medical Journal* 12(2): 2307-2311. DOI: 10.15562/bmj.v12i2.4633

¹Department of Neurology, Faculty of Medicine, Universitas Airlangga, Dr. Soetomo General Hospital, Surabaya, Indonesia.

*Corresponding author:

Paulus Sugianto;
Department of Neurology, Faculty of Medicine, Universitas Airlangga, Dr. Soetomo General Hospital, Surabaya, Indonesia;
paulus.sugianto@fk.unair.ac.id

Received: 2023-05-07

Accepted: 2023-07-06

Published: 2023-08-08

INTRODUCTION

Subdural empyema only comprises 15-25% of localized intracranial pyogenic infections, making it rare.¹ Of all these entities, only 5.6% were interhemispheric.² Distribution of pus on parafalcine and those along the superior and inferior surfaces of the tentorium are considered rare.³ Without prompt treatment, the condition may worsen and result in coma and death within 24-48 hours due to increased intracranial pressure that may or may not be followed by cerebral herniation.^{4,5} Early detection is crucial; surgery combined with appropriate antibiotics is the key to good outcomes. Delay of surgical drainage may cause rapid expansion of the subdural empyema, causing increased morbidity

and mortality.^{6,7} It is also stated in previous studies that interhemispheric subdural empyema had the worst prognosis, and surgery is vital to obtain decompression.⁸ Despite this widely accepted principle, some agree that in subdural empyema, medical therapy has its place in some settings. It is rather controversial whether medical therapy can replace surgery or whether surgery still needs to be executed nonetheless.⁹⁻¹¹

Based on those mentioned above, this article presents a case report of a patient with interhemispheric subdural empyema extending to the cerebellar tentorium who refused to undergo a surgical procedure and was treated with antibiotics as monotherapy, contrary to the known rule for timely surgery in this entity.

CASE REPORT

A forty-year-old male was brought to the ER with decreased consciousness for the last two days, preceded by generalized onset tonic-clonic seizure. The seizure occurred 3 times with a duration of 10 minutes each and intervals of 2 hours without fully regaining consciousness. Right-sided body weakness was noted after the seizure. The patient had had a low-grade fever 10 days prior and intermittent headaches for the last 3 months. The family denied a history of ear pain, ear discharge, or sinusitis but admitted a history of toothache for the last 1 year without prior treatment. History of family disease, hereditary disease, tumor, malignancy, trauma or surgery was denied. History of alcohol or tobacco use

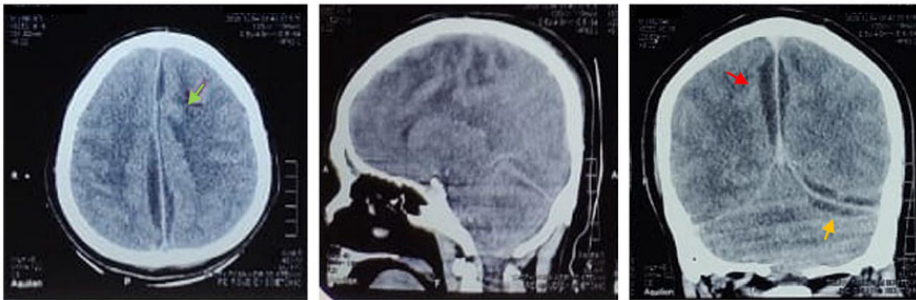


Figure 1. Head Computed Tomography (CT) Scan with Contrast in axial, sagittal, and coronal view (green arrow showing the appearance of mass, red and yellow arrow showing a collection of fluid in para-alpine and cerebellar tentorium, respectively).

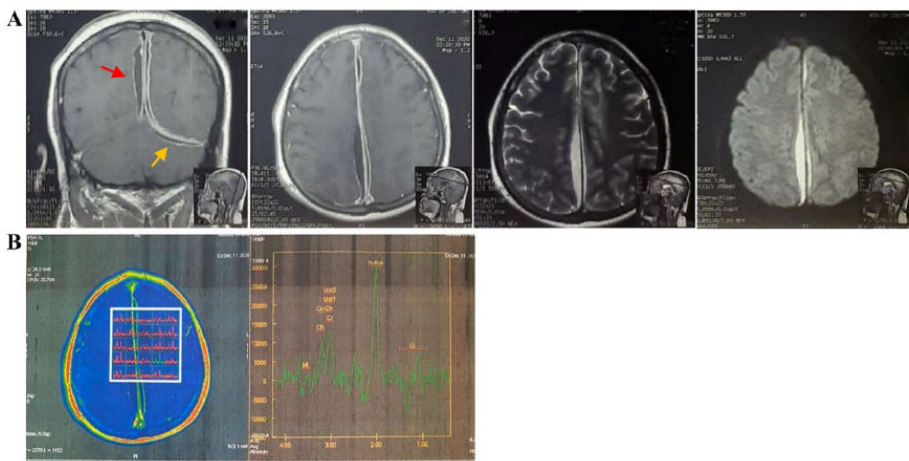


Figure 2. (A) Head Magnetic Resonance Imaging (MRI) in several sequences (from left to right: T1WI with contrast coronal view showing subdural empyema in parafalcine (red arrow) and below cerebellar tentorium (yellow arrow), T1WI with contrast axial view, T2WI and DWI). (B) Magnetic Resonance (MR) Spectroscopy showing increased NAA.

was also denied. Exposure to infection, tuberculosis, HIV/AIDS, and autoimmune disease was also denied. The patient was brought to a regional hospital because of a seizure and unconsciousness. Due to a lack of imaging facility, the patient was referred to our hospital.

During admission, the patient was febrile (39 C), tachycardic (121 beats per minute), tachypnea (28 times per minute), with blood pressure 150/90 mmHg and Glasgow Coma Score (GCS) of E3, V1 and M5. General examinations of the head, neck, thorax, abdomen, pelvis and extremities were unremarkable. A thorough neurological examination revealed right 6th cranial nerve palsy, and right hemiparesis, with a positive Babinski sign on the right side. Meningeal signs were absent, autonomic nervous systems were within normal limits, and other

examinations were difficult to evaluate due to the patient's unconscious state.

His complete blood count revealed Leukocytosis ($18.75 \times 10^9/L$), with other laboratory parameters within normal limits. We performed an emergency head computed tomography (CT) scan with contrast, showing interhemispheric subdural lesions in both right and left cerebral parafalcine and below the left cerebellar tentorium. Also seen was a minimal contrast-enhancing mass on the subcortical region of the left frontal lobe with surrounding perifocal edema, supporting a brain abscess (Figure 1). Lumbar puncture was contraindicated due to the appearance of a mass, and brain MRI with gadolinium contrast was performed (Figure 2). Cerebritis was seen in the cortical-subcortical area of the left parietal lobe with perifocal

edema, alongside subdural abscess on the left para-midline interhemispheric fissure and left tentorium (Figure 1). MR Spectroscopy showed increased N-acetyl aspartate (NAA), consistent with an infection (Figure 1). We consulted to Ear, Nose, and Throat (ENT) Dept to evaluate for the possibility of infection source. Still, the examination found no symptoms or signs of ENT infection. Consultation with Oral Surgery Department revealed multiple periodontitis on teeth 14, 15, 16, 17, 33, 34, and 43.

A diagnosis of Interhemispheric Subdural Empyema with Multiple Periodontitis was established. As indicated, we consulted the Neurosurgery department for drainage. The family refused to go through with surgery for pus drainage on the family's preference, so an empirical antibiotic regimen of ceftriaxone 2 grams every 12 hours combined with metronidazole 500 mg every 6 hours was administered intravenously. Symptomatic therapy includes phenytoin as an anticonvulsant and metamizole as both analgetic and antipyretic.

The patient's consciousness was fully regained on the 7th day of antibiotic therapy. Neurological evaluation revealed right hemiparesis with an MMT score of 4 with right abducens nerve palsy still present. The seizure was controlled, and the patient was no longer febrile, though he still frequently complained of headaches with a Numeric Rating Scale (NRS) of 4-5. On day 14 of antibiotic therapy, his right extremities MMT score increased to 4+, and abducens nerve palsy was no longer found. The headache persisted but was milder, with NRS of 2-3. The antibiotics regimen was continued intravenously until day 21 when his MMT was improved to 5, he had no headache at all, even without analgetic, and his seizure was controlled. He was then discharged in compos mentis without any neurological deficits or complaints. The antibiotics regimen was continued orally for 4 weeks, and during follow-up in the outpatient clinic, he was seizure- and headache-free, and his examination results were uneventful.

DISCUSSION

Most subdural empyema occurs in the second and third decades, mostly

affecting children and young adults, with a preponderance of the male sex.^{10,11} Patients presented in this case represent a small portion of cases regarding age, though befitting regarding sex.

Literature states that subdural empyema, in general, is associated with otitis, sinusitis, meningitis, brain injury and intracranial surgery.¹²⁻²² Sinusitis and mastoiditis were seen in the patient's MRI, but no clinical signs and symptoms attributing to them based on ENT examination. Rather, we found multiple periodontitis involving 7 teeth, leading to suspicion that odontogenic infection may be what led to subdural empyema in this patient. Odontogenic infection is considered a rare source of intracranial infection, and even though some cases have shown its relation to brain abscess, very few were correlated with subdural empyema.²³ Nevertheless, about 350 bacterial strains can be isolated from marginal periodontitis, and they may spread intracranially mainly by systemic hematogenous dissemination, though some suggest direct venous drainage also plays a role.^{24,25}

Early symptoms of subdural empyema are nonspecific, with fever, neck rigidity, headache, and focal seizure, which are usually then followed by neurological deficit and decreased consciousness are the ones frequently reported. Extracranial manifestations, such as periorbital edema, proptosis, facial swelling, diplopia, and painful eye movement, are less frequent.^{26,27} Patient-reported, in this case, having a fever, headache, and seizure at onset, followed by decreased consciousness, hemiparesis and abducens nerve palsy, suitable with symptoms stated in the literature.

Diagnosis of subdural empyema can only be made by imaging, and MRI with gadolinium contrast is preferred over CT and is considered the gold standard.²⁸ Maximal thickness on Head CT is mostly found in the frontal region (51.1%), followed by parietal (27.8%), temporal (14.4%), interhemispheric (5.6%), with the occipital region (1.1%) being the most uncommon.² This patient had interhemispheric subdural empyema, which based on literature, is considered a rare location. More specifically, the

empyema reported in this case was located in falcatentorial, which is even rarer.^{3,29}

Subdural empyema may evolve hastily – Yüksel M et al. reported a case of an expanding interhemispheric subdural empyema by three times its size within only 12 hours, and Prieto and Ortega reported a seven-fold volume increase of parafalcine subdural empyema in 3 weeks despite conservative treatment with antibiotics.^{30,31} This progressive nature of subdural empyema makes the treatment choices controversial; moreover, for those with parafalcine distribution, interhemispheric fissure would be difficult to reach with co-existing brain edema.³¹ Nonetheless, multimodal therapy consisting of surgery combined with antibiotics is the mainstay of treatment for subdural empyema.³²⁻³⁴ Surgical measures play a role in evacuating pus and freeing cerebrospinal fluid obstruction, lowering intracranial pressure. It also aids in the identification of causative organisms and antibiotic sensitivity by obtaining pus for culture.³⁵ Either craniotomy or multiple burr holes can be chosen as a surgical method in subdural empyema, but more studies concluded that a burr hole is less favorable due to its inadequate capability to achieve complete debridement. Exploration is more sufficient in craniotomy, making complete pus evacuation possible.³⁶⁻³⁸ It is important to note, though, that location and size of empyema determine the selection of the best operative procedure – some cases may even need repeat surgeries.³⁹

Conservative treatment may be considered and may result in a favorable outcome, but only in rare circumstances where the patient has no or minimal decrease in consciousness, no major focal neurological deficits, and no midline shift in CT.⁴⁰⁻⁴² Some studies show that medical treatment alone has no greater mortality rate than surgery but greater functional outcomes. This, though, only applied to single hemispheric lesions.⁴³ Infratentorial subdural empyema comprises a fatal condition. While most underwent surgery, cases of successful treatment with broad-spectrum antimicrobial and high-dose steroids were reported, though there is found to be a high possibility of symptoms' relapse.⁴⁴⁻⁴⁶ Some authors

believe that conservative treatment should be attempted in some cases before surgical treatment is undertaken,³⁷ but most believe the opposite: surgery is required regardless of its volume, antibiotics are always necessary, and medical treatment alone may only be utilized in selective cases.^{43,45-47} Based on these, conservative treatment is not likely an option for the patient reported in this study as he was stuporous with a GCS of 9 with right hemiparesis and status epilepticus at the onset. Still, it shall be executed due to the family's rejection of surgery. Consequently, pus could not be obtained for culture; empirical antibiotics were given.

Long-term antibiotic treatment is needed in intracranial subdural empyema for 6 to 8 weeks, with the first 4 weeks given intravenously and followed orally for the rest 2-4 weeks.⁴⁸ Streptococci, staphylococci, *Bacteroides*, *H. influenza*, *Pseudomonas* and anaerobes are common pathogens causing intracranial subdural empyema.³⁴ However, it depends on the source of infection, as *alpha-hemolytic streptococci*, *P. aereginosa*, *Bacteroides*, *S. aureus* are usually the ones accountable in subdural empyema secondary to otitis media, while *S. aureus*, *S. epidermidis*, and *Enterobacteriaceae* accountable for post-traumatic subdural empyema.⁴⁹ Combination of cephalosporins and metronidazole as empiric treatment is widely used and was effective in most cases.⁵⁰⁻⁵²

State of consciousness in subdural empyema was graded into four by Bannister and William: stage I (fully conscious), stage II (drowsy and disoriented), stage III (responsive to certain stimuli), and stage IV (unresponsive to stimuli). These stages were found to be a significant predictor for morbidity of subdural empyema after surgery, with $p < 0.001$. Worst Bannister staging (III or IV) had a higher risk of permanent neurological deficit and seizure in the future.^{2,53-55} Patients reported in this study belong to stage III, denoting the patient had inauspicious morbidity even with surgical intervention, but on the contrary, he had a remarkable improvement with solely medical therapy and even had total recovery with no sequelae during discharge. This outcome may be due to early diagnosis and initiation

of antibiotics treatment despite the family's rejection of surgical intervention, as time is critical in this pathology.

This report concludes that in certain conditions where operative measure could not be taken, medical therapy as unimodal treatment could give favorable outcome if appropriate diagnosis and treatment was made early. It is important to note, though, that due to the nature of the case report, this report may not be applicable and should not be used as sole evidence for treating similar cases.

CONFLICT OF INTEREST

No conflicts of interest concerning the materials or methods used in this study or the findings specified in this paper.

ETHICAL CONSIDERATION

Written informed consent was obtained from the patient/legal representative to publish this case report (including all data and images). The patient/legal representative understands that his/her name and initial will not be published, and due efforts will be made to conceal the patient's identity.

FUNDING

No funding was received for this study.

AUTHOR CONTRIBUTIONS

FHT conceived the idea and collected and analyzed the data. All authors were involved in the drafting and review of the manuscript and approved the final manuscript before submission.

REFERENCES

- French H, Schaefer N, Keijzers G, Barison D, Olson S. Intracranial subdural empyema: A 10-year case series. *Ochsner J*. 2014;14(2):188–194.
- Mat Nayan SA, Mohd Haspani MS, Abd Latiff AZ, Abdullah JM, Abdullah S. Two surgical methods used in 90 patients with intracranial subdural empyema. *J Clin Neurosci*. 2009;16(12):1567–1571.
- Salunke PS, Malik V, Kovai P, Mukherjee KK. Falcotentorial subdural empyema: Analysis of 10 cases. *Acta Neurochir (Wien)*. 2011;153(1):164–169.
- Bruner DI, Littlejohn L, Pritchard A. Subdural empyema presenting with seizure, confusion, and focal weakness. *West J Emerg Med*. 2012;13(6):509–511.
- Osborn MK, Steinberg JP. Subdural empyema and other suppurative complications of paranasal sinusitis. *Lancet Infect Dis*. 2007;7(1):62–67.
- Niklewski F, Petridis AK, Al Hourani J, Blaeser K, Ntoulas G, Bitter A, et al. Pediatric parafalcine empyemas. *J Surg Case Reports*. 2013;2013(8):rjt067–rjt067.
- Oleinikov B, Musa G, Livshitz MI, Kolcheva M, Ramirez M de JE, Nurmukhametov R, et al. Surgical Management of a Pediatric Infratentorial Subdural Empyema as a Complication of Parapharyngeal Abscess. *Cureus*. 2022;14(5):3–7.
- Mat Nayan SA, Abdullah MS, Naing NN, Mohd Haspani MS, Md Ralib AR. Correlations Between Subdural Empyema and Paraclinical As Well As Clinical Parameters Amongst Urban Malay Paediatric Patients. 2008;15(4):19–27.
- Pathak A, Sharma BS, Mathuriya SN, Khosla VK, Kak VK. Controversies in the Management of Subdural Empyema. *Acta Neurochir (Wien)*. 1990;102(1):25–32.
- Greenlee JE. Subdural empyema. *Curr Treat Options Neurol*. 2003;5(1):13–22.
- De Bonis P, Anile C, Pompucci A, Labonia M, Lucantoni C, Mangiola A. Cranial and spinal subdural empyema. *Br J Neurosurg*. 2009;23(3):335–340.
- Adame N, Hedlund G, Byington CL. Sinogenic intracranial empyema in children. *Pediatrics*. 2005;116(3):e461–e467.
- Xue H, Zhang W, Shi L, Zhang Y, Yu B, Yang H. Subdural empyema complicated after trepanation and drainage of chronic subdural hematoma: A case report. *Med (United States)*. 2019;98(52):1–4.
- Patel NA, Garber D, Hu S, Kamat A. Systematic review and case report: Intracranial complications of pediatric sinusitis. *Int J Pediatr Otorhinolaryngol*. 2016;86(1):200–212.
- Sung J, Kwon O, Kim D, Kim K. Bilateral subdural empyemas with meningitis secondary to acute barosinusitis. *Eur Ann Otorhinolaryngol Head Neck Dis*. 2018;135(6):457–459.
- Charlton A, Janjua N, Rejali D. Cotton bud in external ear canal causing necrotising otitis externa and subdural abscess. *BMJ Case Rep*. 2019;12(3):1–4.
- Otto WR, Paden WZ, Connors M, Joerger T, Buzi A, Rizzi M, et al. Suppurative Intracranial Complications of Pediatric Sinusitis: A Single-Center Experience. *J Pediatric Infect Dis Soc*. 2021;10(3):309–316.
- Germiller JA, Monin DL, Sparano AM, Tom LWC. Intracranial complications of sinusitis in children and adolescents and their outcomes. *Arch Otolaryngol - Head Neck Surg*. 2006;132(9):969–976.
- Waseem M, Khan S, Bomann S. Subdural Empyema Complicating Sinusitis. *J Emerg Med*. 2008;35(3):277–281.
- Quraishi H, Zevallos JP. Subdural empyema as a complication of sinusitis in the pediatric population. *Int J Pediatr Otorhinolaryngol*. 2006;70(9):1581–1586.
- Wu JF, Jin Z, Yang JM, Liu YH, Duan ML. Extracranial and intracranial complications of otitis media: 22-year clinical experience and analysis. *Acta Otolaryngol*. 2012;132(3):261–265.
- Yoon J, Redmond M. Check the ear. The importance of ear examinations in assessment of intracranial subdural empyema. *Trop Med Infect Dis*. 2019;4(3):1–8.
- Funakoshi Y, Hatano T, Ando M, Chihara H, Takita W, Tokunaga K, Hashikawa T, Kamata T, Higashi E, Nagata I. Intracranial Subdural Abscess Caused by *Actinomyces meyeri* Related to Dental Treatment: A Case Report. *NMC Case Rep J*. 2020;7(3):135–139.
- Hassine MBH, Oualha L, Derbel A, Douki N. Cerebral abscess potentially of odontogenic origin. *Case Rep Dent*. 2015;2015(1):4–7.
- Moazzam AA, Rajagopal SM, Sedghizadeh PP, Zada G, Habibian M. Intracranial bacterial infections of oral origin. *J Clin Neurosci*. 2015;22(5):800–806.
- Rasheed A, Khawchareonporn T, Muengtawepong S, Suebnukarn S. An unusual presentation of subdural empyema caused by *Porphyromonas gingivalis*. *Ann Indian Acad Neurol*. 2013;16(4):723–725.
- Holland AA, Morriss M, Glasier PC, Stavinoha PL. Complicated subdural empyema in an adolescent. *Arch Clin Neuropsychol*. 2013;28(1):81–91.
- Rebchuk AD, Chang SJ, Griesdale DEG, Honey CR. Non-contrast-enhancing subdural empyema: illustrative case. *J Neurosurg Case Lessons*. 2022;4(6):2–4.
- Van Der Stel T, Treuniet FEE, Hoffmann C, Koppen H. Parafalcine empyema, a tricky infectious cause of headache: A case report. *Am J Emerg Med*. 2015;33(7):992.e1–992.e2.
- Yüksel M, Gürbüz M, Karaarslan N, Caliskan T. Rapidly progressing interhemispheric subdural empyema showing a three-fold increase in size within 12 hours: case report. *Surg Neurol Int*. 2016;7(38):S872–S875.
- Prieto R, Ortega C. Parafalcine subdural empyema: The unresolved controversy over the need for surgical treatment. *Surg Neurol Int*. 2019;10(203):1–8.
- Kazemi KA, Pishjoo M, Safdari Z. Interhemispheric Subdural Empyema in 16 Years Old Boy, A Case Report. *Int J Med Investig*. 2015;4(1):407–409.
- 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.
- Agrawal A, Timothy J, Pandit L, Shetty L, Shetty JP. A review of subdural empyema and its management. *Infect Dis Clin Pract*. 2007;15(3):149–153.
- Alvis-Miranda H, Castellar-Leones S, Elzain M, Moscote-Salazar L. Brain abscess: Current management. *J Neurosci Rural Pract*. 2013;4(5):S67–S81.
- Bok APL, Peter JC. Subdural empyema: burr holes or craniotomy? *J Neurosurg*. 1993;78(4):574–578.
- 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.

38. Nathoo N, Nadvi SS, Gouws E, Van Dellen JR. Craniotomy improves outcomes for cranial subdural empyemas: Computed tomography-era experience with 699 patients. *Neurosurgery*. 2001;49(4):872–878.
39. Güçlü DG. Surgical management of interhemispheric subdural empyemas: review of the literature and report of 12 cases. *Turkish J Trauma Emerg Surg*. 2023;29(4):514–522.
40. 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.
41. 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.
42. Meshref M, Nourelden AZ, Elshanbary AA, AbdelQadir YH, Zaazouee MS, Ragab KM, et al. Subdural empyema due to mixed infections successfully treated medically: A case report with review literature. *Clin Case Reports*. 2022;10(7):1–11.
43. Leys D, Christiaens JL, Derambure P, Hladky JP, Lesoin F, Rousseaux M, et al. Management of focal intracranial infections: Is medical treatment better than surgery? *J Neurol Neurosurg Psychiatry*. 1990;53(6):472–475.
44. Van De Beek D, Campeau NG, Wijdicks EFM. The clinical challenge of recognizing infratentorial empyema. *Neurology*. 2007;69(5):477–481.
45. Hockley AD, Williams B. Surgical Management of Subdural Empyema. *Childs Brain*. 1983;10(5):294–300.
46. Feuerman T, Wackym PA, Gade GF, Dubrow T. Craniotomy improves outcome in subdural empyema. *Surg Neurol*. 1989;32(2):105–110.
47. Gorgan M, Neacsu A, Bucur N, Pruna V, Lipan C, Sandu AM, et al. Brain abscesses: management and outcome analysis in a series of 84 patients during 12 year period. *Rom Neurosurg*. 2013;19(3):175–182.
48. Jolayemi EO, Bankole OB, Ojo OA, Bamigboye B, Adebayo BO, Arekhandia BJ, et al. Contemporary Management of Intracranial Subdural Empyema: An Institutional Experience Abstract. *J West African Coll Surg*. 2022;12(3):56–63.
49. Hendaus MA. Subdural empyema in children. *Glob J Health Sci*. 2013;5(6):54–59.
50. Bernardini GL. Diagnosis and management of brain abscess and subdural empyema. *Curr Neurol Neurosci Rep*. 2004;4(6):448–456.
51. Rasul FT, Chari A, Iqbal MO, Silva G, Hatcher J, Hartley J, et al. The case for early antibiotic commencement and source control in paediatric subdural empyema: A single-centre retrospective case series. *Pediatr Neurosurg*. 2022;57(1):28–34.
52. Dharma BDA, Mulyantari NK, Prabawa IPY. Analisis korelasi kadar serum prokalsitonin dengan jumlah leukosit pada penderita dengan kecurigaan sepsis di RSUP Sanglah, Bali, Indonesia. *Intisari Sains Medis*. 2020;11(1):179–182.
53. Maliawan S, Awyono S, Junus ES, Golden N. A Case Report Massive subdural empyema secondary to infectious parotitis: a case report. *Bali Medical Journal*. 2022;11(3):1884–1886.
54. Risfandi M, Musyari S, Celia C. Acute subdural hemorrhage accompanied with rupture of the inferior vena cava: a case report. *Bali Medical Journal*. 2021;10(2): 507–509.
55. Putra GH, Turchan A, Utomo SA, Parenrengi MA, Fauzi AA, Wibowo A. Causality relationship between Hounsfield Unit in epidural hematoma and subdural hematoma and hematoma expansion. *Bali Medical Journal*. 2023;12(2): 1502–1506.



This work is licensed under a Creative Commons Attribution