



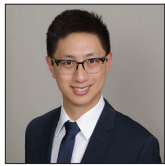
Case Report

Cephalohematomas, an occult nidus for infection and inflammation: A case report and review of the literature

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Received : 23 December 2022

Accepted : 10 January 2023

Published : 03 February 2023

DOI

10.25259/SNI_1158_2022

Quick Response Code:



ABSTRACT

Background: Cephalohematomas (CH) are benign neonatal fluid collections that arise between the periosteum and skull due to birth trauma, and usually resolve spontaneously without intervention. CH may rarely become infected.

Case Description: The authors report a case of sterile CH requiring surgical evacuation in a persistently febrile neonate treated with intravenous (IV) antibiotics for *Escherichia coli* urosepsis. Diagnostic tap of the CH yielded no pathogens, but given the persistence of fevers, surgical evacuation was performed. The patient demonstrated clinical improvement postoperatively.

Conclusion: A systematic review of literature was conducted through a MEDLINE search using the keyword "cephalohematoma." Articles were screened for cases of infected CH and their subsequent management. Clinicopathological characteristics and outcomes of the present case were reviewed and compared to those in the literature. Infected CH were reported in 25 articles describing 58 patients. Common pathogens included *E. coli* and Staphylococcal species. Treatment included a course of IV antibiotics (10 days–6 weeks) and often included percutaneous aspiration ($n = 47$) for diagnostic and therapeutic purposes. Surgical evacuation was performed in 23 cases. To the authors' knowledge, the present case is the first documented report in which evacuation of a culture-negative CH resulted in resolution of the patient's clinical symptoms of sepsis that persisted despite appropriate antibiotic treatment. This suggests that patients with CH should be evaluated through diagnostic tap of the collection if there are signs of local or persistent systemic infection. Surgical evacuation may be indicated if percutaneous aspiration does not result in clinical improvement.

Keywords: Birth trauma, Cephalohematoma, Infection, Pediatric neurosurgery

INTRODUCTION

Cephalohematomas (CHs) occur in 1–4% of live-births, often associated with birth trauma.^[3,12,24] CH is usually self-resolving with minimal sequelae, but bacterial infection may occur in rare instances.^[3,22,24,26] Herein, we report the case of an infant with *Escherichia coli* sepsis and a pre-existing CH who had persistent fevers despite treatment with intravenous (IV) antibiotics. To the author's knowledge, this is the only reported case in which clinical signs of systemic infection resolved only after surgical incision and debridement (I&D) of a sterile CH.

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METHODS

A systematic MEDLINE search was conducted using the keyword “cephalohematoma.” The reference lists from these publications were examined for relevant literature and historical reports [Figure 1]. Reports were excluded if they described non-infectious complications of CH, if the articles were not published in English literature, or if full articles were unavailable to review.

Clinicopathological characteristics and outcomes of the present case were compared to those in the literature. The patient’s chart was reviewed for demographic data, clinical presentation, hospital course, relevant imaging, and follow-up using our electronic medical record system. Clinical case review was deemed not human subjects research and exempt from approval by our Institutional Review Board.

CASE DESCRIPTION

A male infant was born at term through uncomplicated vaginal delivery without instrument-assistance or fetal scalp electrodes. A left-sided CH was noted post-partum. At 3 weeks old, he presented to an outside institution with 1-day of fever, emesis, and diarrhea. He was started empirically on IV ampicillin and gentamicin, and infectious workup later revealed pan-sensitive *E. coli* bacteremia, urinary tract infection, and meningitis. After initial clinical improvement, he was transitioned to monotherapy with IV ampicillin. Shortly thereafter, he became febrile again, so cultures were redrawn and a head ultrasound performed, which was largely unrevealing. The patient was transferred to our institution for further management [Table 1].

On arrival, he was noted to have a large, benign-appearing CH, and a reassuring physical examination, despite being febrile with a rising C-reactive protein (CRP). Magnetic resonance imaging (MRI) of the brain did not reveal any acute intracranial processes or definitive signs of CH infection [Figure 2]. Over the following days, the patient was transitioned to IV ceftriaxone for an up-trending fever curve [Figure 3]. A sterile bedside tap was performed with return of 2 mL of bloody aspirate; cultures and gram stain were negative. The patient remained intermittently febrile and after a multidisciplinary discussion, he was taken for an I&D. Intraoperatively, no gross purulence or abnormalities of the underlying bone were identified. Histopathological examination confirmed a diagnosis of CH without infection or organisms. All surgical cultures and gram stain were negative. The patient tolerated the procedure with no complications.

Our patient became afebrile on postoperative day (POD)1 and remained clinically improved for the remainder of his hospitalization [Figure 3]. After surgical drain removal and

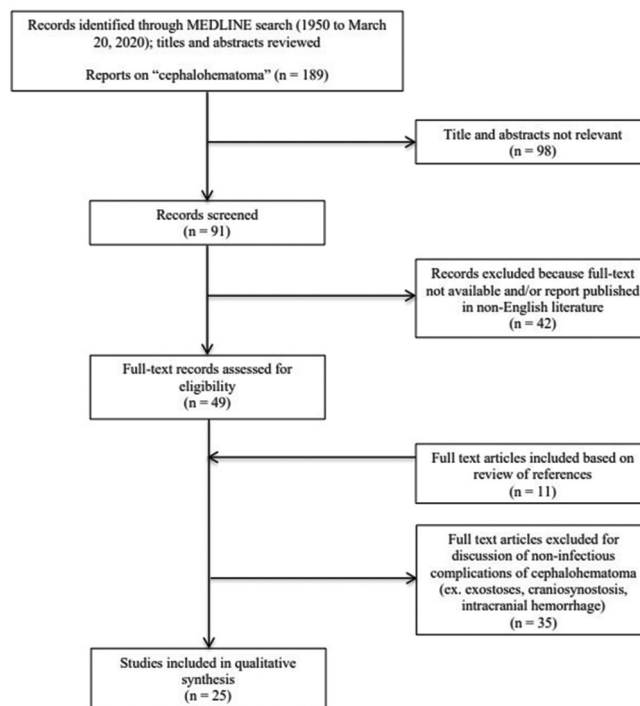


Figure 1: PRISMA flow diagram. Citations identified and evaluated on literature review of infected cephalohematomas. Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). *Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement*. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

PICC line placement, he was discharged on POD6 with a 21-day course of IV ceftriaxone. The patient was seen in clinic on POD12 and noted to be doing well with no reaccumulation of the CH.

Literature review

A MEDLINE search was conducted using the keyword “cephalohematoma.” Full-text, English-language articles were reviewed for management and outcomes of infected CH. This resulted in 25 publications, documenting 58 cases [Table 2].^[1-4,6,7,9,10,12-21,23-29]

The majority of cases 52% ($n = 30$) had one or more concurrent infections,^[1-4,6,7,12,13,15,17,18,21,24,25,27,28] while 48% ($n = 28$) did not have any.^[1,3,9,10,14,16,19,20,23,26,29] *E. coli* was the most common organism isolated ($n = 32$; 55%),^[1,3,4,7,9,12,13,15,17,21,23,25-29] followed by polymicrobial infections ($n = 8$; 14%).^[2,10,18] Only one case reported no growth in the CH culture despite Gram-negative rods noted on gram stain.^[20]

All patients were treated with IV antibiotics; some followed by a course of oral antibiotics. Duration varied from 10 days to 6 weeks, depending on concerns for osteomyelitis or other concurrent infections. The majority were treated with

Table 1: Notable laboratory findings and events for our presented case throughout the course of his hospitalizations (abnormal values in red).

Hospital day (event)	-5 (admission to OSH)	-4	-3	-2	-1	1 (transfer to LUMC)	7	8	9
WBC (k/uL)*	8.8	-	-	13.3	-	13.6	-	-	-
CRP (mg/dL)*	23	-	-	-	-	128.3	-	-	259.6
Blood Cx	<i>E. coli</i>	<i>E. coli</i>	NGTD	NGTD	-	NGTD	NGTD	-	NGTD
Other	Urine Cx and CSF PCR with <i>E. coli</i> ; Respan negative; Influenza PCR negative				Respan negative Head US: 7.35×2.96×7.2 cm fluid collection with some internal echogenicity in the left scalp in area of known CH		Stool PCR negative MRI Brain: no acute intracranial process, and definitive abscess or infection in CH		Procalcitonin* 0.44 ng/mL
IV Antibiotics (dosing)	Ampicillin (75mg/kg q6h) and Gentamicin (4mg/kg q12h)			Ampicillin (75mg/kg q6h)			Ceftriaxone (50 mg/kg q12h)		
Hospital day	10 (CH bedside tap)	11	12 (CH I&D)	13	14 (PICC placed)	15 (drain removed)	16	17	18 (d/c home)
WBC (k/uL)*	-	-	30.9	-	14.8	-	-	13.6	-
CRP (mg/dL)*	-	-	-	-	-	-	-	-	-
Blood Cx	-	NGTD	-	-	NGTD	-	-	NGTD	-
Other	CH aspirate NGTD (gram stain, AFB, anaerobe/aerobe, fungal Cx negative)		OR Cx NGTD (AFB, anaerobe/aerobe, fungal Cx negative; gram stain with moderate WBCs)					Respan neg	
IV Antibiotics (dosing)	Ceftriaxone (50mg/kg q12h)								

AFB: Acid fast bacilli, CH: Cephalohematoma, CRP: C-reactive protein, CSF: Cerebrospinal fluid, Cx: Culture, d/c: Discharge, I&D: Incision and debridement, IV: Intravenous, neg: Negative, LUMC: Loyola University Medical Center, MRI: Magnetic resonance imaging, NGTD: No growth to date, OR: Operating room, OSH: Outside hospital, PCR: Polymerase chain reaction, PICC: Peripherally inserted central catheter, Respan: Respiratory panel PCR, US: Ultrasound, WBC: White blood cell, *E. coli*: *Escherichia coli*. *Laboratory reference ranges: WBC 5–14 k/uL normal, CRP <8.1 mg/dL normal, Procalcitonin <0.06 ng/mL normal or >0.5 ng/mL bacterial sepsis possible

needle aspiration alone ($n = 34/58$).^[1-3,24,26] Surgical I&D was performed in 23 cases,^[1,2,4,6,7,10,12,14-21,23,25,27-29] sometimes after needle aspiration ($n = 13$). One case was successfully treated with IV antibiotics alone.^[9] The most common complications of infected CH were osteomyelitis ($n = 10$),^[1-3,6,9,16,19,20,24,25] and overlying scalp necrosis or abscess ($n = 9$).^[2,9,12,17,18,20,26,28] The mortality rate of cases reported in our literature review was 8.6% ($n = 5/58$; range 0–11%).^[1,3,18]

DISCUSSION

CH infection is rare and may occur early (<2 weeks of life) due to direct birth trauma or hematogenous seeding, or late (≥ 3 weeks of life) due to overlying cellulitis.^[28] Clinical manifestations can be local – increasing size, fluctuance, tenderness, erythema, skin abrasion with purulence – or systemic – fever, decreased feeding, irritability. As in the

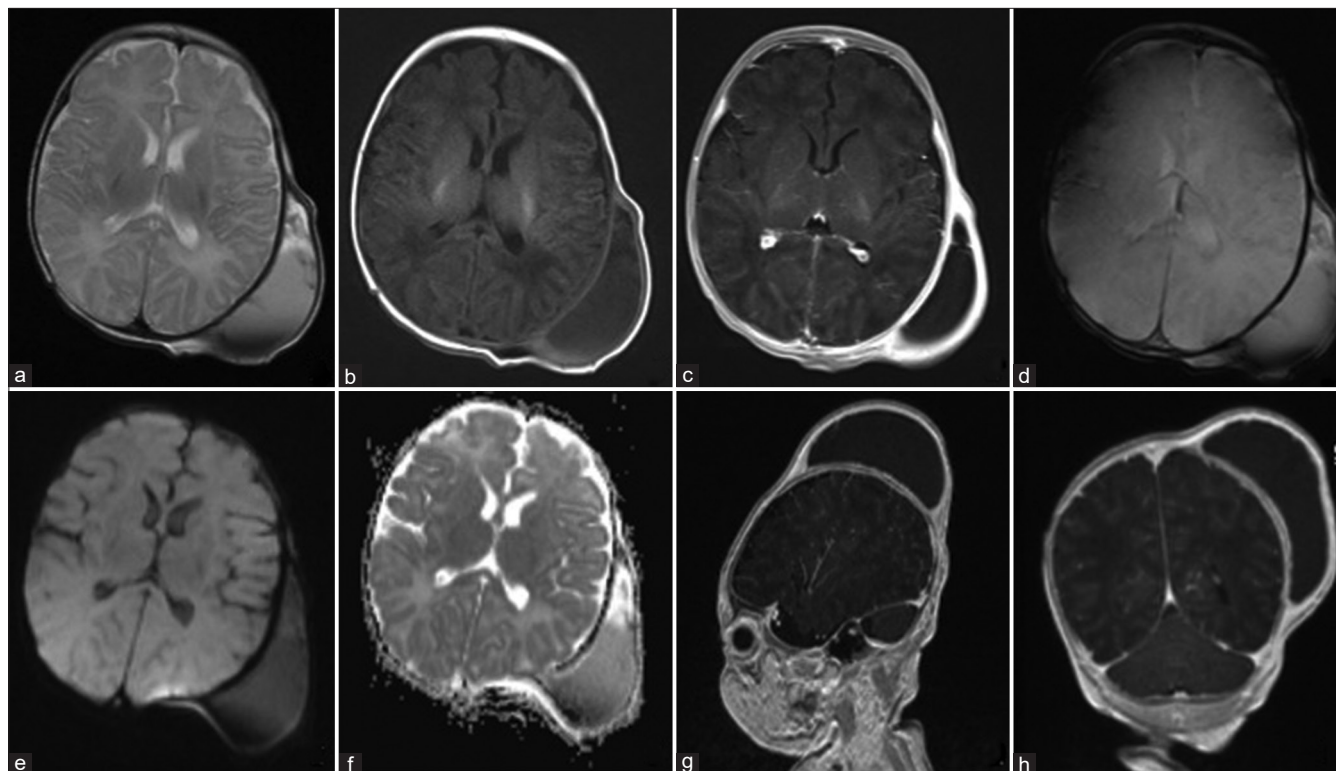


Figure 2: (a-h) Magnetic resonance imaging (MRI) study of the patient's brain on presentation to our institution. Select axial T2-weighted non-contrast (a), T1-weighted non-contrast (b), T1-weighted post-contrast (c), gradient echo (d), diffusion-weighted imaging (e), apparent diffusion coefficient (f), sagittal T1-weighted non-contrast (g), and coronal T1-weighted non-contrast (h) images from an MRI study of the patient's brain. Images demonstrate a large heterogeneous extracranial fluid collection overlying the left parietal skull consistent with a cephalohematoma. The collection does have some enhancement along its margins, but does not demonstrate restricted diffusion. No significant surrounding subcutaneous edema is identified. No acute intracranial findings or abnormalities noted.

present case, imaging studies may be of limited diagnostic value. MRI can identify associated abscesses or intracranial findings, but may not definitively detect the presence of infection.^[4,13] Computed tomography scan may demonstrate bony changes indicative of osteomyelitis, but are not 100% sensitive and bone scan findings may be confounded by local tissue hyperemia.^[13,28] In cases without clear local signs of infection, the presence of other sources of infection may lead to a delay in diagnosis of infected CH.^[1,6,7,13,15,17,19,23-25]

Aspiration and surgical interventions are contraindicated in uncomplicated CH due to risks of contamination with bacteria.^[13,22] However, given the lack of adequate non-invasive diagnostic tools, aspiration should be considered in select circumstances: development of local signs of infection, relapse, or delayed resolution of clinical signs systemic infection.^[13] This usually enables identification of a causative pathogen to guide antibiotic therapy and may be therapeutic if enough purulent material is aspirated.^[3] Surgical I&D of infected CH is recommended if insufficient material is able to be aspirated, or in situations of extensive scalp necrosis and abscess formation.^[1,2,4,6,7,10,12,14-21,23,25,27-29] A course of IV antibiotics (1–6 weeks) is indicated, with

optimal duration depending on the presence of other concurrent infections.^[3]

The presented case makes a unique contribution to the body of literature because this patient's CH did not demonstrate evidence of infection on any diagnostic modality. It may be argued that because our patient received IV antibiotics for several days before needle aspiration or I&D, the CH may have been sterilized by appropriate treatment of pan-sensitive *E. coli*. There has been growing evidence for polymerase chain reaction testing of culture-negative fluid collections that are suspected to have harbored bacterial infections following initiating of empiric antibiotics. This test was not performed for our patient, but may be helpful to reveal a causative organism.^[8] However, our review also includes multiple cases in which patients received appropriate antibiotic treatment for 5–15 days before positive cultures and gross purulence obtained through needle aspiration or I&D.^[1,6,7,15,17,23,25,27,29] Another possible explanation for this clinical scenario may be that the significant size of the CH and the inflammatory cascade involved in tissue injury and wound healing was sufficient to induce non-infectious pyrexia in this infant.^[5,11] Although the exact mechanism is unclear, the authors believe

Table 2: Literature review of previously reported cases of infected CH.

Author, Year	n	Age/Gender	Predisposing factors	Presentation	CH location	Other infections	Organism	Treatment	CH-related Complication
Levy et al., 1967 ^[15]	1	3do M	None	Abdominal distension, fever, enlarging CH	L parietal	Bacteremia	<i>E. coli</i>	Needle aspiration; I&D; Antibiotics IV×2 wk f/b PO×12 d	Skull fracture
Lee and Berg, 1971 ^[14]	1	5do M	None	Fevers, enlarging CH	R parietal	None	Bacteroides	Needle aspiration; I&D; IV antibiotics×duration NS	None
Ellis et al., 1974 ^[7]	1	5do F	Forceps delivery	Sepsis, progressive anemia, hyperbilirubinemia	L parietal	Bacteremia	<i>E. coli</i>	Needle aspiration; I&D; Antibiotics IV×3 wk f/b PO×1 wk	None
Hedge, 1980 ^[10]	1	10do F	Forceps delivery, FSE	Erythema with purulent drainage from FSE site	R parietal	None	<i>E. coli</i> , anaerobic streptococcus	Needle aspiration; I&D; IV antibiotics×10 d	None
Listinsky et al., 1986 ^[16]	1	14wo M	PROM, FSE	Fevers, irritable, enlarging and fluctuant L CH	B/L parietal	None	<i>Streptococcus pneumoniae</i>	Needle aspiration; I&D; IV antibiotics×duration NS	OM, epidural empyema
Mohon et al., 1986 ^[9]	1	16do M	None	Jaundice, umbilical stump with purulent drainage, toxic appearing, erythematous CH	L parietal	None	GBS	Needle aspiration; I&D; Antibiotics IV×4 wk f/b PO×2 wk	Presumed OM
Nightingale et al., 1986 ^[20]	1	16do M	Forceps delivery, FSE, presumed endometritis, confirmed chorioamnionitis	Tender, fluctuant R parietal CH with skin necrosis	B/L parietal	None	Culture negative after gram negative rods on gram stain	Needle aspiration; I&D w/partial excision of bone; Antibiotics IV×3 wk f/b PO×2 wk	OM, scalp necrosis
Blom, 1993 ^[1]	1	3wo M	FSE	Fever, increasing size CH	L parietal	None	<i>E. coli</i>	I&D with bony debridement; IV antibiotics×6 wk	OM
LeBlanc et al., 1995 ^[13]	1	5do M	None	Septic shock, DIC	B/L parietal	Bacteremia, meningitis	<i>E. coli</i>	Needle aspiration; IV antibiotics	Death
Goodwin, 2000 ^[9]	1	14do M	Vacuum-extraction	Febrile, seizures, lethargy	R parietal	Bacteremia, meningitis	<i>E. coli</i>	Needle aspiration; IV antibiotics×3 wk	None
	1	17do F	None	Ruptured blister overlying left CH with purulent sanguinous drainage	B/L parieto-occipital	None	<i>E. coli</i>	IV antibiotics×4 wk	Presumed OM, scalp abscess

(Contd...)

Table 2: (Continued).

Author, Year	n	Age/Gender	Predisposing factors	Presentation	CH location	Other infections	Organism	Treatment	CH-related Complication
Dahl, 2002 ^[6]	1	5do NS	PROM, maternal fever, FSE	Fevers, seizures, lethargy	R parietal	Meningitis	<i>Escherichia hermannii</i>	Needle aspiration; I&D; IV antibiotics×6 wk	Presumed OM
Brook, 2005 ^[2]	6	Age range: 7–25do M: n=4 F: n=2	Multiple factors per case: vacuum-extraction (n=4); PROM (n=2); amnionitis (n=4); FSE (n=2); instrumental delivery (n=3)	NS	Occipital (n=3); parietal (n=2); temporal (n=1)	Bacteremia (n=3)	Polymicrobial (2–4 organisms): bacteroides, Peptostreptococcus, Prevoella, <i>E. coli</i> , GBS, <i>S. aureus</i> , <i>P. acnes</i>	I&D (n=4); Needle aspiration only (n=2); IV antibiotics×18–41 d	OM (n=1), scalp abscess (n=2)
Chang, 2005 ^[3]	28	Mean age: 17.8±13.9do M: n=17 F: n=11	Forceps delivery or vacuum-extraction (n=12; 43%)	Erythema (79%), increasing size of CH (68%), fluctuant mass (46%), fever (64%), poor appetite (39%), leukocytosis (82%), elevated CRP (61%); obvious scalp erosion (n=7); prior aspiration (n=1)	NS parietal (n=23; 82%); b/l parietal (n=4; 14%); NS (n=1; 4%)	None (n=18; 64%), sepsis (n=7 <i>E. coli</i> ; n=1 <i>Saureus</i>), urinary tract infection (n=2 <i>E. coli</i>), meningitis (n=3 <i>E. coli</i>)	<i>E. coli</i> (n=16); <i>S. aureus</i> (n=5), Proteus (n=2), Salmonella group E (n=1), <i>Klebsiella pneumoniae</i> (n=1), GBS (n=1), CoNS (n=1)	Needle aspiration (mean 4.4 d after admission; range: 1–12 d); IV antibiotics×1–2 wk unless other systemic infection	OM (n=1 proteus), death (n=3)
Nishi et al., 2005 ^[21]	1	8do F	Forceps delivery	Crusting of CH, abdominal mass	Parietal NS	Adrenal abscess	<i>E. coli</i>	Needle aspiration; I&D; IV antibiotics×duration NS	None
Chen, 2006 ^[4]	1	23do M	None	Fever, irritability	L parietal	Bacteremia	<i>E. coli</i>	I&D; IV antibiotics×4 wk	None
Kersten, 2008 ^[12]	1	5do F	FSE, gestational DM	Fevers, enlarging mass on head f/b rupture and drainage	L parieto-occipital	Bacteremia	<i>E. coli</i>	I&D; IV antibiotics×20 d	Scalp abscess
Paul, 2009 ^[23]	1	16do M	None	Fever, jaundice, enlarging CH, RSV	R parietal	None	<i>E. coli</i>	Needle aspiration; I&D; IV antibiotics×2 wk	None
Weiss, 2009 ^[27]	1	31do F	None	Fever, irritability, decreased PO intake	L parietal	Bacteremia, meningitis	<i>E. coli</i>	Needle aspiration; I&D; IV ampicillin×3 wk	None

(Contd...)

Table 2: (Continued).

Author, Year	n	Age/Gender	Predisposing factors	Presentation	CH location	Other infections	Organism	Treatment	CH-related Complication
Wong, 2012 ^[28]	1	17do F	Washing with waste-water*	Fluctuant CH with erythema, tenderness	R parietal	Bacteremia	<i>E. coli</i>	I&D; Antibiotics IV×10 d f/b PO×5 d	Scalp necrosis
Vale, 2013 ^[25]	1	5do F	Vacuum-extraction	Fevers	R parietal	Bacteremia, meningitis	<i>E. coli</i>	I&D; IV antibiotics×8 wk	Epidural empyema, OM, hydrocephalus
Staudt, 2016 ^[24]	1	13do M	Vacuum-extraction	Fevers, fluctuant, warm and erythematous R parietal CH	R parietal	Bacteremia, pneumonia	<i>Morganella morganelli</i>	Needle aspiration; IV meropenem×6 wk	Presumed OM
Zimmerman, 2016 ^[29]	1	5wo F	Vacuum-extraction	Fever, tender CH with eventual fluctuance	L parieto-temporal	None	<i>E. coli</i>	Needle aspiration; I&D; IV antibiotics×3 wk	None
Malik et al., 2018 ^[18]	1	3do F	FSE, unknown GBS status s/p IV PCN, chorioamnionitis, funisitis	Discoloration of scalp overlying CH with subgaleal hematoma and foul-smelling drainage	L parietal	Bacteremia	<i>E. coli, Enterococcus faecalis, Bacteroides fragilis</i>	I&D; IV antibiotics×duration NS	Meningitis, encephalitis, scalp abscess, OM, death
Wang, 2018 ^[26]	1	5wo M	Vacuum-extraction	Drainage from enlarging nodules over CH	R parietal	None	<i>E. coli</i>	Needle aspiration; Antibiotics IV×3 d f/b PO×7 d	Scalp abscess
Liu et al., 2019 ^[17]	1	3do F	None	Fevers	NS parietal	Bacteremia, pneumonia	Multidrug-resistant <i>E. coli</i>	Needle aspiration; I&D; IV antibiotics×16 d	Scalp necrosis

E. coli: *Escherichia coli*, *S. aureus*: *Staphylococcus aureus*, *P. acnes*: *Propionibacterium acnes*, B/L: Bilateral, CH: Cephalohematoma, c-section: Caesarean section, CoNS: Coagulase-negative staphylococcus, CRP: C-reactive protein, d: Day old, DIC: Disseminated intravascular coagulation, F: Female, f/b: Followed by, FSE: Fetal scalp electrode, GBS: Group B beta-hemolytic streptococcus, I&D: Incision and debridement, IV: Intravenous, L: Left, M: Male, mo: Month old, NS: Not specified, NSVD: Normal spontaneous vaginal delivery, OM: Osteomyelitis, PCN: Penicillin, PO: Per os, PROM: Prolonged rupture of membranes (>18 h), R: Right, RSV: Respiratory syncytial virus, s/p: Status post, wk: Week, wo: Week old. *Cultural practice of washing child with water used to rinse rice grains believed to decrease inflammation

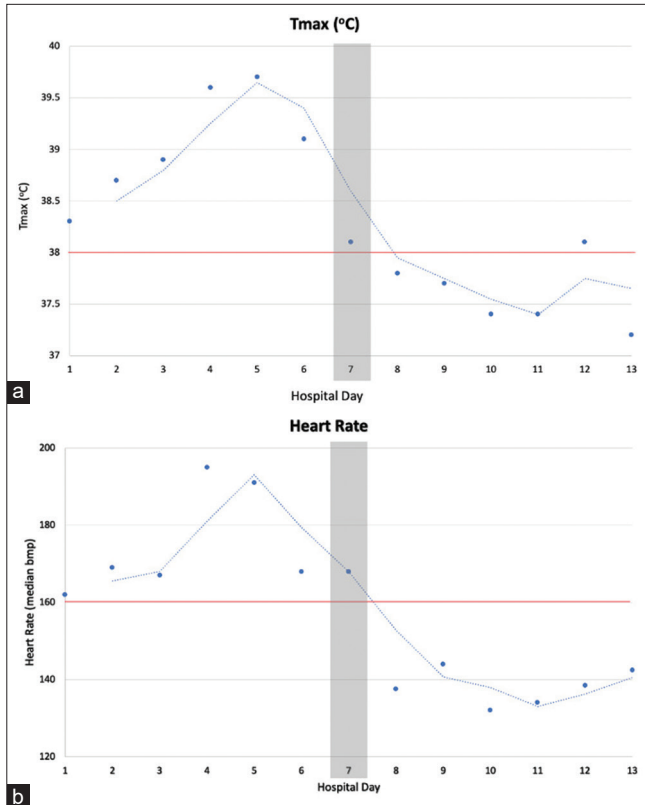


Figure 3: Documentation of patient's vital signs during his admission at our institution. Patient's body maximum temperature in °C (a) and median recorded heart rate (beats per minute; bpm) (b), as charted per nursing documentation for each 24-h period throughout the course of the patient's admission. Patient continued to be intermittently febrile ($>38^{\circ}\text{C}$ or 100.4°F ; red line) and tachycardic (>160 bpm; red line) until after the patient was taken to the operating room for surgical I&D of the cephalohematoma, on his 7th day of admission to our institution (grey rectangle).

that CH evacuation was still indicated in this case given our patient's persistent signs of systemic infection.

CONCLUSION

Optimal management of infected CH often requires a combination of IV antibiotics and evacuation. In the absence of clear local signs of infection, patients demonstrating a relapse or persistent signs of systemic infection should still be considered for definitive CH evacuation, even with negative cultures.

Ethics approval/consent to participate

Due to its retrospective nature, clinical case review was deemed not human subjects research and exempt from approval by the Loyola University Chicago Stritch School of Medicine Institutional Review Board (LU#213917) on July 22, 2020. Therefore, the Loyola University Chicago Stritch

School of Medicine Institutional Review Board has waived the need for the patient's and/or parents'/legal guardian's written informed consent for publication. All included patient information has been deidentified.

Author contributions

Daphne Li is the first author having performed the majority of data extraction, literature review, data analysis, and writing of the manuscript. John Tsiang contributed to data analysis and drafting of the manuscript. John Tsiang, Kimberly Mackey, and Andrew Bonwit contributed to the critical review of the manuscript. Suguna Pappu is the principal investigator having contributed to the majority of design and review of the manuscript. All authors read and approved the final manuscript.

Declaration of patient consent

Patient's consent not required as patient's identity is not disclosed or compromised.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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How to cite this article: Li D, Tsiang JT, Mackey KA, Bonwit A, Pappu S. Cephalohematomas, an occult nidus for infection and inflammation: A case report and review of the literature. *Surg Neurol Int* 2023;14:38.

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