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Pediatric Brain Abscess and Pyoderma after Penetrating Cranial Trauma in Gaza

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Abstract. Children injured during armed conflict are particularly vulnerable to infectious complications when trauma occurs in settings characterized by disrupted healthcare services, poor sanitation, malnutrition, and limited access to antimicrobial therapy. This report describes a 2-year-old Palestinian girl who sustained penetrating cranial trauma from shrapnel during an explosion in Gaza and subsequently developed a left frontoparietal brain abscess accompanied by multiple pustular skin lesions. Non-contrast computed tomography demonstrated a large intracranial abscess, which was treated by percutaneous aspiration and systemic antimicrobial therapy. Culture of the intracranial aspirate yielded coagulase-negative *Staphylococcus* (CoNS), whereas the cutaneous lesions yielded *Staphylococcus aureus*. The patient showed clinical improvement following systemic antibiotics and topical mupirocin. Follow-up imaging later demonstrated residual structural abnormalities requiring continued surveillance. The differing microbiological findings do not establish a direct causal relationship between the cutaneous infection and brain abscess; penetrating trauma and subsequent wound contamination remain plausible pathways. This case illustrates how resource constraints, disrupted referral systems, limited diagnostics, and restricted antimicrobial availability complicate the management of pediatric neurotrauma in humanitarian emergencies.

Keywords: brain abscess; Gaza; humanitarian health; penetrating brain injury; pyoderma

Introduction

Israel's occupation of Palestine has been ongoing since 1948. The conflict itself predates the 1948 Balfour Declaration, forcing civilians out of territories they had inhabited for generations (Mahwati & Nanda, 2022). Since then, the conflict has escalated, resulting from clashes between Palestinian resistance groups and the occupation, resulting in civilian casualties. In the ongoing conflict at the end of 2023, six health facilities operated by the charity Médecins Sans Frontières in central and southern Gaza reported more than 90,000 injuries from Israeli bombs, missiles, and military fire throughout 2024 (Nicolai et al., 2025). A UN report in mid-2024 stated that 24,000 of the patients injured in Gaza by Israeli armed attacks were children (UNICEF, 2024).

Following the destruction of infrastructure and public facilities during the conflict, essential life-support systems were severely disrupted. Sanitation infrastructure, including water pumps and desalination facilities, was damaged, and healthcare services were substantially compromised. Hospitals also experienced damage affecting oxygen supplies, clean-water systems, and electricity, further constraining essential services for the population of Gaza.

In addition to the destruction of infrastructure caused by bombing, Israel also closed the border crossings, which serve as entry and exit points for residents and daily food supplies for Gazans. Because residents' agricultural land in Gaza was also destroyed by Israeli military bombing and destruction, the ability to meet their daily food needs is severely limited. For daily sustenance, residents rely on food shipped from outside Gaza, primarily through the Rafah crossing, aid, or through traders who still have limited access. However, since late 2023, Israel has destroyed the Rafah crossing and, with military assistance, has closed it, putting conditions inside Gaza at risk of severe famine.

During a humanitarian volunteer mission in Gaza in August 2025, the first author served as a dermatologist under the auspices of the Indonesian Red Crescent in collaboration with Rahma Worldwide. Clinical observations at the pediatric medical center of Al Rantisi Hospital in Gaza City indicated that malnutrition frequently accompanied illness among pediatric patients, while many children presenting to dermatology services had concurrent skin infections and nutritional vulnerability. These observations provide contextual insight into the conditions under which the present case was encountered; they should not be interpreted as population-level estimates unless supported by formal service data.

The combination of malnutrition and traumatic injury created particularly vulnerable patient groups during the conflict. These included individuals with physical injuries, people living without adequate support systems, and those with conditions that may increase clinical vulnerability, such as malnutrition, intellectual disabilities, and chronic illnesses requiring additional care. In this setting, post-surgical wound infections, wound dehiscence, infections in untreated burns, and complications of inadequately managed chronic wounds were among the clinical problems encountered.

Medicine shortages, including limited access to antibiotics and dermatological preparations, further complicated the management of skin and wound infections. During the first author’s deployment, pyoderma and furunculosis were frequently encountered in dermatology services. The first author maintained informal records for 130 patients, while formal medical records at Al Daraj clinic covered more than 200 patient encounters managed by the first author and a local dermatologist. Because the exact proportion of pyoderma cases was not formally confirmed in the author response, no percentage estimate is reported here. Topical fusidic acid and mupirocin were not routinely available at the treating facilities, and only limited quantities brought by the humanitarian medical team could be used for selected patients.

Within this setting, the first author encountered a toddler with an intracranial abscess, prominent facial and scalp furunculosis, and an incompletely healed cranial wound after prior shrapnel removal. The coexistence of a brain abscess and cutaneous infection raised a clinically important question: whether the intracranial infection was related to the concurrent pyoderma or more plausibly reflected direct inoculation or postoperative wound contamination following penetrating cranial trauma.

Life-threatening complications affecting vulnerable patients in daily practice pose particular challenges when diagnostic, therapeutic, and referral resources are severely constrained.

This case report aims to describe the patient’s clinical course and critically assess the plausible origins of the intracranial infection by integrating dermatological and neurosurgical perspectives. It also examines how disrupted diagnostic services, limited antimicrobial availability, poor sanitation, nutritional vulnerability, and constraints in referral and continuity of care shaped clinical decision-making in a humanitarian conflict setting. The purpose is not to attribute a single causal pathway beyond the available evidence, but to show how clinical uncertainty and health-system disruption intersect in the management of complex pediatric trauma.

Case Presentation

Present History

A 2-year-and-2-month-old Palestinian girl from Beit Lahya, weighing approximately 13 kg and measuring 1 m in height, presented to the Emergency Department at Shifaa Hospital on August 17, 2025, at approximately 14:00 because of abnormal discharge from a partially healed wound on the left side of her head. Her past health history, based on a combination of caregiver interview, available hospital records, physical examination, and laboratory findings, did not indicate organ transplantation, leukemia, congenital disease, underlying malignancy, human immunodeficiency virus infection, long-term steroid use, or autoimmune disease. The discharge was yellowish, occasionally mixed with a brownish stain resembling old blood, thick, and malodorous, and had been present for approximately 2 weeks. Three days before admission, she developed an acute high fever of approximately 39 °C, measured by her mother. An antipyretic temporarily reduced the fever, but it recurred. Her activity level declined, she became less playful, and her appetite decreased. She also developed frequent projectile vomiting. The night before admission she vomited twice and once again on the day of admission. On examination, she was conscious with a Glasgow Coma Scale score of 15/15 and a supple neck. Right-sided upper- and lower-limb weakness was present (4/5). Her temperature was 38.7 °C. Complete blood count showed a white blood cell count of $24.0 \times 10^3/\mu L$, with 29.2% lymphocytes, 3.7% monocytes, and 67.1% granulocytes; hemoglobin was 11.0 g/dL and the platelet count was $897 \times 10^3/\mu L$. A non-contrast head CT scan revealed a large left frontoparietal brain abscess with extracranial herniation through a bone defect (Figure 2).

The patient underwent emergency percutaneous aspiration of the brain abscess through a left parietal bone defect later that evening. The neurosurgeon also noted multiple pustular eruptions on the face, neck, and both arms (Figure 1), prompting dermatological consultation. Approximately 30 mL of dark yellow pus was aspirated; the abscess capsule was not excised. Samples from the intracranial aspirate and pustular lesions were sent for bacterial culture and antimicrobial susceptibility testing. Initial treatment consisted of ceftriaxone (250 mg i.v. every 12 hours) and vancomycin (200 mg i.v. every 8 hours). After five days, culture of the intracranial aspirate yielded coagulase-negative *Staphylococcus* (CoNS), which was susceptible to erythromycin, cefuroxime, amikacin, chloramphenicol, rifampicin, levofloxacin, and cefoxitin and resistant to amoxicillin-clavulanic acid. Culture of the pustular lesions yielded *Staphylococcus aureus*, which was susceptible to erythromycin, cefuroxime, amikacin, chloramphenicol, rifampicin, and levofloxacin and resistant to amoxicillin-clavulanic acid and cefoxitin. The systemic regimen was subsequently changed to cefuroxime (150 mg i.v. every 8 hours). According to the authors, this choice was considered closer to the available treatment guidance and was also influenced by the limited availability and quantity of antibiotic options in Gaza, where some available or donated medicines were expired or near expiry. Topical mupirocin was initiated for the pustular lesions and was supplied from a limited quantity brought by the humanitarian medical team because it was not routinely available at the treating facility. After one week, the patient became afebrile and the pustular eruptions had gradually improved (Figure 3).

Past History

Three days after discharge was first noticed from the partially healed wound on the left side of her head, her mother observed multiple pustular eruptions on the face, neck, and both arms. Her mother initially thought the rash represented an allergic reaction, possibly related to the hot summer conditions while the family was living in a tent. At the same time, she noticed progressive weakness of the patient's right arm and leg, which had been present since treatment at Patient Friend's Benevolent Society Hospital.

Figure 1. Clinical features on August 17, 2025.
A. Multiple pustular eruptions appearing on the face, neck, and some on both arms.
B. Half-healed wound on the left parietal region with pustular eruptions on the scalp.
Source: Author's clinical documentation, 2025

On July 13, 2025, she was brought to Patient Friend's Benevolent Society Hospital with multiple traumatic injuries sustained in an explosion while she was sleeping in her tent in the Al-Mukhabarat area of Gaza City. She was unconscious and had severe abdominal trauma requiring emergency laparotomy. She also had a wound on the left side of the head with embedded shrapnel. Because the abdominal injuries were immediately life-threatening, the head wound was evaluated during the operative period.

According to the patient's mother, perforations of the colon and stomach were identified during the initial laparotomy and a splenectomy was performed. She also reported that the approximately 7-cm scalp wound underwent debridement, shrapnel removal, and suturing. No operative report or contemporaneous cranial imaging from this initial admission was available to the authors; therefore, the depth of shrapnel penetration, extent of bone injury, dural involvement, and other intraoperative cranial findings could not be independently verified.

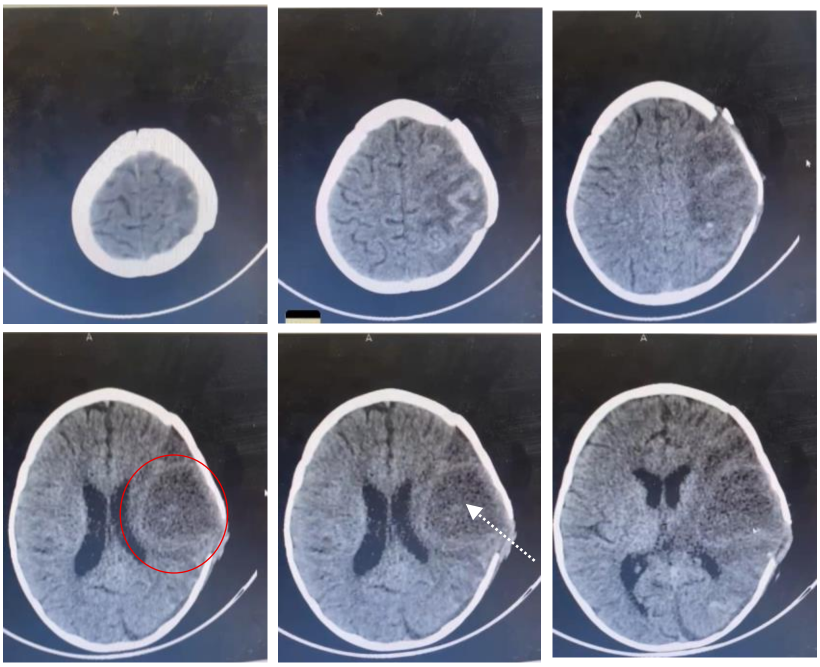

Figure 2. Non-contrast head CT findings on August 17, 2025.
A non-contrast head CT scan showed a circular space-occupying lesion with a slightly hyperdense ring and surrounding low-density changes. A frontoparietal bone defect with extracranial brain herniation is visible. The red circle indicates the area of parietal bone loss, and the dashed white arrow depicts the aspiration trajectory.
Source: Authors' documentation, 2025

After the laparotomy, she was admitted to the intensive care unit (ICU) for 10 days. Her condition improved, although her mother noticed mild weakness of the right arm and leg. She was subsequently transferred to the general ward. During that admission, she experienced three brief generalized seizures within a single episode of illness, each lasting less than one minute, with recovery of consciousness between events. Her mother reported the seizures, and an antiseizure medication was administered. Three days later, she underwent repeat laparotomy because of dehiscence of the abdominal surgical wound. No further seizures were reported after that episode. She was discharged on July 29, 2025, in good condition.

Figure 3. Clinical pictures on August 24th, 2025.
The multiple pustular eruptions on the face, neck, and both arms had gradually improved. The discharge from the wound was also improved. The weakness on the right side of her arm and limb also improved. No seizure was encountered during treatment.
Source: Author's clinical documentation, 2025

In November 2025, approximately three months after the humanitarian medical team had returned to their home country, the third author received follow-up information from the patient's mother. Only the written CT interpretation was provided; the CT images themselves were not available to the authors. The report described left frontoparietal encephalomalacic changes with an underlying 2.7 × 2.6 cm cystic-appearing structure containing a small internal hyperdense focus, interpreted as a possible residual foreign body or bone fragment. The findings raised concern for a persistent or recurrent intracranial process, although the patient was reportedly clinically asymptomatic, with no neurological deficit or active skin infection at that time. After reviewing the report, the second author advised neurosurgical reassessment because recurrent abscess formation could not be excluded and repeat surgical exploration might be required. No further clinical or imaging follow-up information was available to the authors.

Discussion

Dermatology perspective

Pyoderma refers to skin infections caused by pyogenic bacteria, the most common of which are *Staphylococcus sp*. and *Streptococcus sp* (Miller, 2019). *Staphylococcus aureus* is the most common cause of skin infections found in the *Staphylococcus* group (Bowen et al., 2015). While pyoderma is caused by the *Streptococcus* group, the most commonly found species is pyogenes (Bowen et al., 2015).

Clinical manifestations of pyoderma can vary, affected by several factors such as the type of bacteria, the area of skin infected, and the patient's immune status (PERDOSKI, 2021). Environmental factors, such as humid and hot weather, are also determining factors in the clinical spectrum of pyoderma (Miller, 2019). The type of infection is divided based on the pathophysiological mechanism, namely, primary or secondary infection (Benson & Paul, 2016). Primary pyoderma occurs when bacteria infect healthy/intact skin (Benson & Paul, 2016). While secondary pyoderma is a bacterial skin infection with a barrier disorder, it has experienced previous skin disorders (Benson & Paul, 2016). In our patient, both types of pyoderma were found, namely primary pyoderma in the form of furunculosis on the face and secondary pyoderma in the form of Surgery Site Infection (SSI) on the scalp after shrapnel removal procedure.

The diagnosis of pyoderma, which is generally caused by primary *Staphylococcus* infection, includes impetigo, folliculitis, furuncle, carbuncle, abscess, and paronychia (Miller, 2019). Meanwhile, pyoderma due to *Streptococcus* infection is generally found in the clinical form of impetigo, ecthyma, erysipelas, and cellulitis (Miller, 2019). The most frequently found type is *Streptococcus pyogenes*, which is a beta-hemolytic group A *Streptococcus* (Miller, 2019). Skin infections by non-group A *Streptococcus* bacteria are rare (Miller, 2019). *Streptococcus* infections can originate from droplets or skin lesions of sufferers (Benson & Paul, 2016; Miller, 2019).

Staphylococcus aureus is a common cause of pyoderma and can colonize the anterior nares and skin (Sakr et al., 2019). In this patient, the microbiological findings from the cutaneous and intracranial sites were not identical: the pustular lesions yielded *Staphylococcus aureus*, whereas the brain abscess yielded coagulase-negative *Staphylococcus* (CoNS), without further species identification. This distinction is clinically important because it does not establish a direct microbiological link between the furunculosis and the intracranial abscess. Instead, the findings support consideration of more than one plausible infectious pathway.

Staphylococcus aureus is the most common cause of furunculosis and can invade hair follicles, producing inflammation in the follicles and surrounding tissues (Linz et al., 2023; Miller, 2019). *Staphylococcus aureus* has relatively high virulence and is an important cause of bacterial skin infections, including surgical-site infection (Linz et al., 2023). Several CoNS species, including *Staphylococcus* haemolyticus and *Staphylococcus* epidermidis, are normal skin flora but may also be associated with infections involving foreign materials. CoNS generally have lower virulence than *Staphylococcus aureus*, but they are recognized causes of abscesses and are more frequently implicated in hosts with impaired immunity (Linz et al., 2023).

Surgery Site Infection (SSI) is defined as an infection that occurs at the surgical site within 30 days of the surgical procedure (Borchardt & Tzizik, 2018). In principle, SSI is a secondary pyoderma, which is a bacterial infection of a pre-existing skin lesion. In developed countries, the SSI rate is about 2–5% of all surgically operated patients (Fuglestad et al., 2021). However, in developing countries, such as Palestine, the estimated rate of SSI is approximately 9.6% (Elshami et al., 2020). Several studies published between 2015 and 2019 stated that the incidence of SSI in postcranial surgical procedure patients varies between 0.1 and 8.0% (Boregard et al., 2025). Meanwhile, the incidence rate in Korea was 1.9% despite pre-operative antibiotics (Jeong & Yee, 2018).

There are endogenous and exogenous factors that can increase the risk of SSI (Boregard et al., 2025). Endogenous risk factors for SSIs include advanced age, obesity, poor glucose control, malnutrition, and pharmaceutical treatment with corticosteroids and/or other immunosuppressive medications (Boregard et al., 2025). Remote infections represent another endogenous risk factor; these are coincident infections that occur at a site remote from the surgical wound (e.g., pneumonia, urinary tract infection, wound/skin infection, colonization with a multi-drug-resistant organism) (Abu Hamdeh et al., 2014; Boregard et al., 2025). Apart from that, anemic condition in patients with cranial surgery is also thought to be a risk factor for SSI (Abu-Zant et al., 2025). Exogenous risk factors encompass the prolonged duration of the procedure, surgical/aseptic techniques, and the operating room (OR) environment (Boregard et al., 2025).

Other studies state that the main causal factors that increase the risk of SSI are due to cerebral fluid leakage which causes the formation of access for germs to enter the intracranial area, the use of intraoperative dexamethasone which aims to control brain edema but has an immunosuppressive effect, instrument contamination, sterility factors in the operating room, and the duration of surgery of more than 2.5–4 hours, in craniectomy cases (Jeong & Yee, 2018). Another study on the risk of bacterial infection after surgical procedures of scalp or any hairy area of the skin revealed the difficulty of eliminating normal skin flora, such as *Staphylococcus*, that colonize hair follicles. Hidden bacterial colonies are prone to being missed during cleansing procedures, and as surgery lasts longer, bacteria within the hair follicles can migrate to the skin's surface and contaminate the surgical field (Liu et al., 2024). The most common causative organisms of neurosurgical SSIs are coagulase-negative *Staphylococci* (CoNS), *Cutibacterium acnes*, and *Staphylococcus aureus* (Abu Hamdeh et al., 2014; Boregard et al., 2025). *Cutibacterium acnes* is considered to be an endogenous infection (i.e., caused by bacteria from the patients' own skin flora) (Swedish Institute for Standards, 2015), while SSIs due to CoNS and *S. aureus* may be endogenous or exogenous (Boregard et al., 2025).

The chronology suggests that purulent discharge from the cranial wound preceded the appearance of widespread pustular lesions and was followed by fever, progressive limb weakness, and intracranial symptoms. The damaged scalp and cranial bone provided a potential route by which organisms from a non-sterile environment could reach deeper tissues. However, because the initial operative record and cranial imaging were unavailable, the extent of the original penetrating injury and the precise route of infection cannot be reconstructed with certainty.

From a microbiological perspective, CoNS-associated postoperative or foreign-body-related infection is a plausible explanation for the intracranial abscess, particularly in the presence of an incompletely healed wound and prior shrapnel injury. At the same time, the concurrent furunculosis reflects a separate or overlapping cutaneous infectious process in a patient exposed to nutritional vulnerability, impaired hygiene, and difficult wound care conditions. Because the organisms recovered from the two sites were not demonstrated to be identical, neither direct spread from the furunculosis nor a single common source can be proven. The case is therefore better interpreted as a differential etiological assessment than as evidence for one definitive causal pathway.

The patient's vulnerability arose from the combination of young age, penetrating blast injury, postoperative wounds, nutritional compromise, and limited access to medicines and hygiene resources. She received systemic antimicrobial therapy for the intracranial infection and topical mupirocin for the cutaneous lesions; the latter was available only through limited humanitarian supplies. In accordance with recommendations for furunculosis accompanied by systemic symptoms, combined topical and systemic therapy may berequired (Lin et al., 2021). The case-specificfindings should nevertheless be distinguished from broader field observations regarding medicine shortages and the high burden of skin infection in Gaza.

During the first author's humanitarian practice, pyoderma was frequently encountered in community and pediatric care settings, while topical dermatological medications were often unavailable. These observations illustrate the practical consequences of disrupted pharmaceutical supply chains for otherwise treatable infections. They are presented here as field observations rather than epidemiological estimates unless supported by formal service data.

The dermatological perspective therefore highlights that prevention and treatment of infection depend not only on antimicrobial selection but also on access to clean water, hygiene materials, wound care, nutrition, and a reliable supply of essential medicines. In prolonged conflict settings, interruption of these basic components can increase the risk that localized infections become difficult to control, particularly among children and other vulnerable populations.

Neurosurgery perspective

Traumatic brain injury (TBI) is an increasing source of mortality and morbidity in adults and is an important cause of disability and death in children. It is classified as mild, moderate, or severe according to the extent of brain damage (Dewan et al., 2019; Ginsburg & Smith, 2025; Menon et al., 2010; Murray et al., 2007; Wilson et al., 2022). Even though penetrating brain injury (PBI) and blast-related head injuries are less prevalent causes of TBI, they carry the most lethal form and a significantly poorer prognosis. According to projectile velocity, PBI is divided into two types: high-velocity (such as bullets and shell fragments) and low-velocity (such as shotgun and air-gun pellets) projectiles (Alao et al., 2024; Kazim et al., 2011).

Various complications may occur in cases of PBI, such as vascular complications (including traumatic intracranial aneurysms, subarachnoid haemorrhage), traumatic cerebrospinal fluid leaks, and epilepsy, as well as infectious complications such as meningitis, cerebral abscess, and so on. High-velocity penetrating injuries are generally associated with greater lethality, but patients who suffer injuries from low-velocity projectiles require extra attention due to the potential complications (Jamali et al., 2021).

Infectious complications account for 1% to 5% of cases of PBI in civilians, as compared with 4% to 11% of cases of PBI among military personnel. Retained contaminated foreign objects, skin, hair, and bone fragments in brain tissues are the main causes of infectious complications. Various complications, such as local wound infections, meningitis, ventriculitis, or cerebral abscesses, might also emerge (Aarabi, 1988, 1989, 1990; Aarabi et al., 1998, 2000). The origin of brain abscesses is pericranial contiguous focus, hematogenous spread from a distant focus of infection, and direct inoculation of a pathogen after neurosurgical procedures or PBIs (Alvis-Miranda et al., 2013). Abscess after trauma usually forms within 2 to 4 weeks. In some rare cases, abscess formation after trauma may take 2 to 3 months or even longer (Savitri et al., 2020).

In this case, direct inoculation associated with the penetrating cranial injury remains a clinically plausible source of the brain abscess. The later CT demonstrated a frontoparietal bone defect in the region of the previous injury, while caregiver history indicated that the initial scalp wound had undergone debridement, shrapnel removal, and closure. However, no initial cranial CT or operative report was available to confirm the depth of penetration, the extent of bone removal, dural involvement, or any dural repair. Direct intracranial contamination should therefore be considered a plausible mechanism rather than a retrospectively proven event.

During the exploratory cranial procedure performed by the second author, purulent material was observed intracranially in continuity with purulent material at the infected scalp wound, and specimens were obtained from both sites. This operative observation supports a contiguous infectious pathway; however, the differing microbiological findings from the intracranial and cutaneous specimens mean that a single microbiological source cannot be established with certainty. The approximately three-week interval between the initial injury and abscess diagnosis is consistent with the reported 2–4-week period in which post-traumatic brain abscesses may develop. Staphylococcal organisms are recognized causes of post-traumatic brain abscess, alongside other pathogens such as *Clostridium spp.* (Mahabeer et al., 2014).

Managing penetrating military injuries in a war zone setting is different than managing the common civilian penetrating brain injuries that we usually encounter in our practice due to a variety of factors (Bell et al., 2009, 2010; Ragel et al., 2010; Rosenfeld et al., 2015): 1) technical factors (missile calibre and velocity); 2) lack of sophisticated medical facilities in a war zone; 3) lack of equipment and supplies; and 4) lack of sufficient medical personnel and experienced neurosurgeons on site. The general rule in medical practice is to treat every human soul, and as physicians, we have an ethical obligation to do this. In a war zone, however, with such poor conditions, important decisions have to be made. Having a treatment protocol and algorithm is a must to avoid wasting valuable and limited resources. Such a protocol will help triage, that is, deciding whom to treat or not treat, and whom to fly back home or refer to a fully equipped trauma centre hospital. Deciding if a patient will be treated or not is a nightmare for any neurosurgeon, as we are perfectionists and accustomed to doing the best for our patients, no matter the conditions. Without evidence-based guidelines, such decisions become ethical dilemmas. Moreover, in those whom we decide to treat, certain surgical and management controversies arise, such as indications of decompressive craniectomy (Bell et al., 2010; Ragel et al., 2010; Stephens et al., 2010), bone reconstruction (Stephens et al., 2010), dural closure (Agarwalla et al., 2010; Ragel et al., 2010), and indications to extract bullets (Agarwalla et al., 2010; Rosenfeld et al., 2015; Sakr et al., 2016).

The patient's early management occurred in a setting where multiple life-threatening injuries competed for immediate attention and access to imaging and specialist services was limited. The initial emergency laparotomy addressed critical abdominal trauma, while contemporaneous cranial imaging was reportedly not performed. The later clinical course illustrates how restricted diagnostic capacity and referral options can complicate recognition of intracranial complications in a war-zone health system.

Because complete contemporaneous records from the initial hospital admission were unavailable, the reasons for subsequent diagnostic and referral decisions cannot be determined with confidence. Caregiver history indicated that neurological symptoms, including limb weakness and seizures, occurred during the admission. Rather than attributing specific intentions to the treating clinicians, these events should be understood in the context of competing emergency priorities, fragmented documentation, limited imaging access, and constrained specialist referral. Such conditions may delay recognition of evolving intracranial infection even when clinical warning signs are present.

Following aspiration and antimicrobial treatment, the patient became afebrile, the pustular lesions and cranial wound improved, and the neurological deficits diminished. Follow-up information obtained in November 2025 indicated no active neurological deficit or skin infection, although the written CT report described residual structural abnormalities and raised concern for a possible persistent or recurrent intracranial process. Neurosurgical reassessment was recommended; subsequent follow-up was not available to the authors.

The neurosurgical perspective underscores the importance of maintaining access to imaging, specialist trauma care, antimicrobial therapy, referral pathways, and medical evacuation when indicated. In humanitarian emergencies, protection of functioning health facilities and safe access for patients, medical personnel, medicines, and essential equipment are integral to continuity of care and to reducing preventable complications after penetrating neurotrauma.

Integrated Clinical Interpretation

Taken together, the available evidence does not support a definitive causal pathway linking the cutaneous pyoderma directly to the intracranial abscess. The microbiological difference between the cutaneous and intracranial isolates weakens a simple explanation in which the skin infection directly seeded the brain abscess. Direct inoculation associated with penetrating cranial trauma remains plausible, but the absence of the initial CT scan, detailed operative documentation, dural findings, and microbiological assessment of the original wound prevents definitive reconstruction of the route of infection. Postoperative or wound-related infection is also plausible because CoNS are recognized organisms in neurosurgical and foreign-body-associated infections and the patient developed purulent discharge from an incompletely healed cranial wound. The most defensible interpretation is therefore a differential etiological assessment in which several pathways remain possible but none can be proven from the available evidence.

Humanitarian and Health-System Implications

The clinical course should also be understood within the wider constraints of healthcare delivery during armed conflict. Management of penetrating neurotrauma requires timely imaging, surgical expertise, microbiological testing, antimicrobial therapy, wound care, nutritional support, referral capacity, and longitudinal follow-up. In this case, restricted diagnostic capacity, fragmented referral pathways, limited medicine availability, inadequate sanitation, nutritional vulnerability, and difficulties maintaining continuity of care complicated management beyond the injury itself. These factors demonstrate that outcomes in complex trauma depend not only on the primary injury and technical clinical decisions, but also on the resilience and accessibility of the surrounding health system. Sustained humanitarian access, protection of healthcare services, reliable supply chains for essential medicines, and safe referral or evacuation pathways are therefore integral components of effective clinical care in prolonged conflict settings.

Limitations

This case report has several limitations. First, detailed records from the patient's initial treatment, including cranial imaging and the operative report describing the shrapnel injury, were unavailable; consequently, parts of the early clinical history relied on caregiver recollection. Second, microbiological characterization was incomplete, particularly regarding species-level identification of the isolates, limiting direct comparison between the cutaneous and intracranial infections. Third, the precise route of intracranial infection could not be established, and the proposed mechanisms therefore remain clinical interpretations rather than proven causal pathways. Fourth, this is a single case occurring under exceptional humanitarian conditions, which limits generalization to other patients or settings. Finally, longitudinal assessment was constrained by the humanitarian situation and geographical separation of the treating medical team, although follow-up information was subsequently obtained through the third author.

Conclusion

This case demonstrates the complexity of diagnosing and managing infectious complications following penetrating cranial trauma in a child living in a resource-constrained conflict setting. The concurrent presence of pyoderma and brain abscess initially raised the possibility of a shared infectious origin; however, the differing microbiological findings did not establish a direct link between the cutaneous and intracranial infections. Direct inoculation associated with penetrating trauma and subsequent wound or postoperative contamination remain clinically plausible mechanisms, but the exact route of infection cannot be determined from the available evidence. The case further shows that diagnostic limitations, disrupted referral pathways, medicine shortages, poor sanitation, nutritional vulnerability, and difficulties in maintaining follow-up can substantially complicate otherwise standard trauma and infection management. Effective care for pediatric neurotrauma in humanitarian emergencies therefore depends not only on appropriate surgical and antimicrobial treatment but also on sustained access to diagnostics, essential medicines, specialist referral, wound care, nutrition, and continuity of healthcare services.

Ethical Considerations

The patient's parents were informed of and verbally consented to the use of the clinical information and photographs for publication purposes during the authors' contact with the family. Written consent specifically for publication could not subsequently be obtained because renewed in-person contact with the family was not feasible in the prevailing humanitarian circumstances.

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