Case Report

Forensic Multidisciplinary Analysis in Battered Child Syndrome: Integrating Bruise Age Determination, Autopsy, and Imaging for Accurate Diagnosis

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ABSTRACT

Background: Battered Child Syndrome (BCS) is a grave medicolegal illness caused by repeated physical violence, usually resulting in severe injury or fatality. It is essential to differentiate the abuse injuries from other medical illnesses, such as coagulation disorders or metabolic bone disorders, that can mimic the pattern of injury.

Case Presentation: A two-year-old boy was found dead under his mother's boyfriend's care. The investigation included a clinical history assessment, external examination, autopsy, histopathology, forensic imaging, and differential diagnosis. Relatives, medical professionals, and police gave the clinical history. External examination provided bruises of multiple colors; autopsy provided rib fractures, subdural hematoma, pulmonary contusions, and organ damage. Histopathology confirmed injuries of different ages, while forensic imaging (X-ray, CT scan, UV/IR photography) detected fractures in the skeleton and hidden bruises. Multidisciplinary assessment disclosed overwhelming evidence of recurrent NAT in accordance with BCS. Shaken baby syndrome, Munchausen syndrome by proxy, sudden infant death syndrome, coagulopathy, and metabolic bone disease were excluded as differential diagnoses.

Conclusion: The case in question underscores the crucial importance of multidisciplinary forensic evaluation in distinguishing between abuse and medical illness. Reports require alterations to regular procedures, increased clinical suspicion, and system intervention for vulnerable children.

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Introduction

Battered Child Syndrome, described initially by Kempe in 1962 [1, 2], and characterized by repeated physical injury by violence, but not appreciated as the injury is masked because the abuse is slight. For the determination of the real cause of injury or death, forensic examination should be conducted [3, 4].

Due to resistance from families and society to reporting, child abuse continues to be a problem globally. There are systemic and cultural factors causing high rates of physical, sexual, and psychological abuse in the majority of the nations in Asia, and children who come from troubled families are particularly vulnerable [5, 6]. Detection and documentation by forensic medicine are critical to determine and report child abuse [3, 4]. Since hemolysis changes the color of a bruise over time, bruise age becomes an important forensic marker for approximating the sequence of injury. Since hemoglobin degrades over time, bruises change color, and forensic scientists can determine when the wounds were sustained. To identify repeated trauma, bruises change color from red (oxygenated hemoglobin) to blue/purple (deoxygenated), green (biliverdin), yellow (bilirubin), and brown (hemosiderin) [7–9]. Detection is improved with the use of UV and infrared imaging for identifying subtle or occult bruises [8, 10].

BCS is established by postmortem evidence of organ trauma, internal bleeding, and fracture. Acute and chronic injury are distinguished by histopathology, as well as by exclusion of the conditions that may be suggestive of abuse [9]. The location of lesions is also important: bruising of the trunk, spine, arm, or inner thigh is suggestive of trauma, while falls tend to occur on the forehead, knees, or palms [11]. This research demonstrates how combining high-tech imaging, histopathology, and bruise-age confirmation can establish repeated trauma and distinguish BCS from other conditions.

Case Presentation

This BCS case was investigated using a multidisciplinary forensic approach, which included a review of clinical history, external examination, autopsy, histopathology, forensic imaging, and differential diagnosis. Each is crucial for confirming repeated trauma and excluding other causes of death.

Evaluation of Clinical History

Multiple sources, including the mother and extended family, medical professionals who had previously treated the child, and child protection authorities, were consulted for the child's medical and social history. The suspicion of non-accidental trauma was strengthened by these accounts, which offered context about previous episodes of unexplained injuries, inconsistent caregiver explanations, and prior medical visits.

External Analysis

There were multiple bruises of different colors and shapes, as would be expected from injuries at various stages of healing.

The Autopsy

Demonstrated organ trauma, pulmonary contusions, subdural hematomas, and broken ribs.

Histopathology inspection

Determined multiple-stage injuries: hemosiderin-containing macrophages in older lesions and neutrophilic inflammation in newer lesions.

Forensic Imaging

Forensic imaging X-ray and CT scan revealed subdural hematoma and fractures of the bone; UV/IR photography revealed clandestine bruising which the naked eye could not detect.

Differential Diagnosis

Ruled out systematically by imaging, laboratory workup, and forensic investigation were differential diagnoses like coagulopathy disorders, metabolic bone disease, Munchausen syndrome by proxy, shaken baby syndrome, and SIDS to provide a solution to the diagnostic dilemma.

Results

Forensic analysis of the case yielded strong evidence of chronic trauma typical of Battered Child Syndrome (BCS). External findings of autopsy, histopathologic findings, forensic imaging, and differential diagnosis all supported non-accidental trauma, culminating in the ultimate conclusion. The results are categorized as follows:

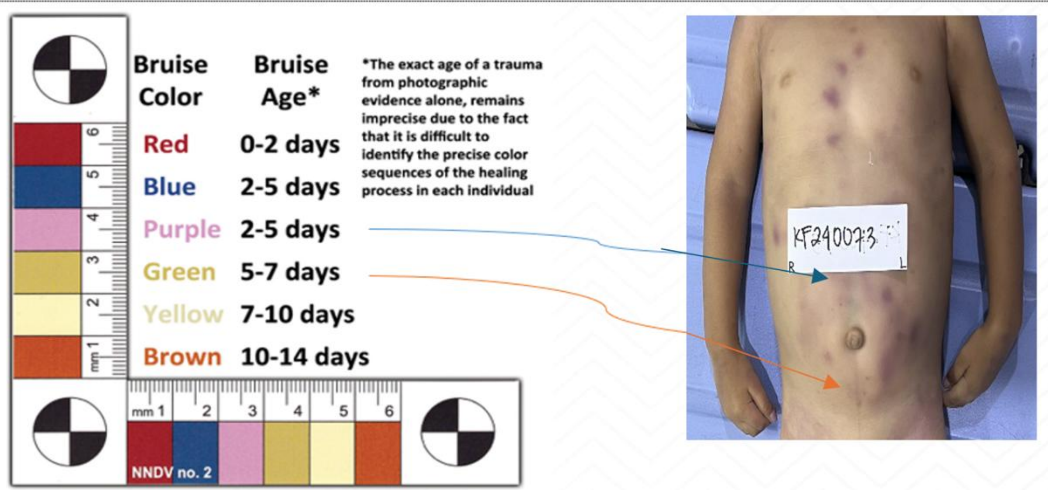

Figure 1. Clues for Bruises Showing different bruise colors for age determination.

Table 1. External Examination Findings

Body Region	Bruise Color	Estimated Age of Injury	Possible Cause
Forehead	Light purple	1–2 days	Blunt force trauma
Upper arms	Dark purple	4–5 days	Repetitive gripping or striking
Lower back	Yellow-green	7–10 days	Older contusion, healing process
Thighs	Red-purple	Fresh (0–12 hours)	Recent blunt force trauma

External Examination Findings

Bruises were heterogeneously colored and varied in size on the trunk and limbs, illustrating repeated abuse (Figure 1). Bruise color changes from red-purple to yellow-green, indicating multi-temporal injuries (Table 1).

Autopsy Findings

Injuries to the internal parts were three healing rib fractures, a subdural hematoma, pulmonary contusions, and organ injury (Table 2). Both old and fresh injuries together continuously demonstrated repeated trauma (Figure 2).

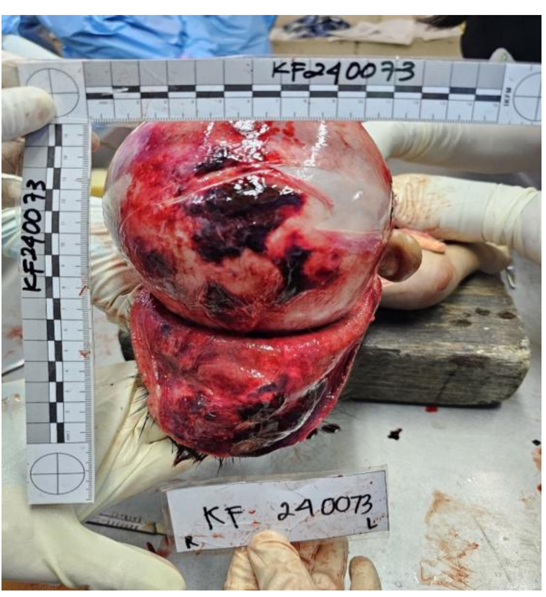

Figure 2. Autopsy Findings for Head Injuries.

Table 2. Internal Injuries Identified During Autopsy

Injury Type	Location	Findings	Significance
Rib fractures	3rd, 4th, and 5th ribs (left)	Partial healing present	Evidence of past trauma
Internal hemorrhage	Liver and kidney	Extensive bleeding	Indicative of blunt force trauma
Brain injury	Subdural hematoma	Older clot formation	Suggests previous head trauma
Lung damage	Contusions in both lungs	Associated with blunt impact	Possibly due to repeated chest compression

International Journal of
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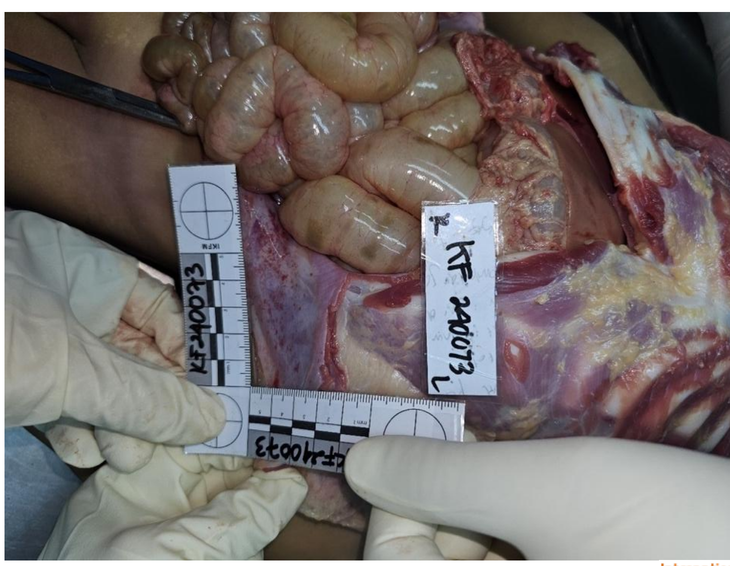

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Figure 3. The per-autopsy photograph of ecchymotic infiltration of the abdominal wall.

Histopathological Analysis

Microscopy validated injury chronology: active bruising had neutrophilic invasion, chronic lesions had hemosiderin-laden macrophages, and lung tissue had alveolar hemorrhages, all consistent with repeated, inflicted trauma (Figure 3).

Forensic Imaging Findings

CT and X-rays revealed rib fractures and head injury. Inward-facing perimortem bruises, which were invisible externally, were evidenced by UV/IR photography. Imaging verified autopsy and histopathology, providing value to the evidence for BCS (Figure 1).

Differential Diagnosis Exclusion

Potential mimics were excluded. Normal ranges of coagulation excluded bleeding disorders; radiographs excluded metabolic bone disease; the pattern of injury and no credible accidents established non-accidental trauma (Table 3).

Discussion

Child abuse injury differential from medical illness (e.g., coagulopathy or metabolic bone disease) continues to be a medicolegal priority. Here, the addition of bruise age assessment, autopsy, histology, and forensic imaging yielded concordant evidence of serial non-accidental injury, as in line with best forensic practice [3, 4].

Table 3. Differential Diagnoses Excluded in Battered Child Syndrome Forensic Evaluation

Condition	Findings	Ruling
Shaken Baby Syndrome	No retinal hemorrhages, no signs of violent shaking	Ruled out
Munchausen Syndrome by Proxy	No evidence of fabricated symptoms by caregivers	Ruled out
Sudden Infant Death Syndrome (SIDS)	Presence of trauma and internal injuries	Ruled out
Bleeding Disorders	Normal coagulation test results	Ruled out

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Clinical History Relevance

Contradictory statements of the caregivers, previous minor injuries, and the non-credible accidental mechanisms were shown in information from the family members, as well as from health care professionals. Consistent with research indicating the importance of social and contextual history in child abuse investigations, this background supported forensic evidence of multiple traumatic events [5, 6].

Differential Diagnosis Consideration

Coagulopathy was ruled out by normal coagulation tests, as reported in accordance with the protocols described by Laaksonen et al. (2024) [12]. Additionally, the radiographic images were within normal limits, ruling out metabolic bone disease, in line with Dempsey & Blau (2020) [13]. In the opinion of Sacco et al. (2023), the absence of retinal hemorrhages was reason enough to rule shaken baby syndrome out [11]. Supporting evidence for Munchausen syndrome by proxy was also absent, and due to the documented traumatic injuries, SIDS was also excluded [2].

Key Results in Relation to Objectives

The aim was to establish whether the injuries were indicative of repeated abuse (Battered Child Syndrome). The findings of multi-temporal bruises, rib fractures, and subdural hematoma were highly supportive of this aim. Imaging and histopathology enhanced the diagnostic precision and legal accuracy, in line with prior reports that a multidisciplinary assessment is essential for medicolegal certainty [12, 14].

Comparison with Literature

Our evidence corroborates prior work, showing that rib fractures are strong indicators of injury [12,13] and that bruises indicate repeated injury [7, 8]—the importance of imaging and histopathology in conjunction for forensic accuracy [9, 10].

Limitations and Interpretation

Due to its single-case report nature, its generalizability is limited. Estimating bruise age remains somewhat subjective and can vary depending on environmental and biological factors [7]. If imaging is not supported by autopsy and histopathology, it may also result in artifacts or overinterpretation [11]. However, combining several forensic techniques improves the reliability of findings and lessens diagnostic bias. Nevertheless, integrating multiple forensic methods reduces diagnostic bias and enhances the reliability of conclusions [10].

Relationship Between Variables

Histopathology, imaging, internal hemorrhages, skeletal injuries, and bruise patterns all supported the accurate diagnosis of BCS and directed child protection and legal actions [3, 9, 10, 12, 13].

Conclusion

In this case, determining Battered Child Syndrome was achieved most comprehensively by integrating clinical data, body outlines, autopsy, histopathology, and imaging results. By integrating these disparate methods, reliable medicolegal certificates were created, differential diagnoses were made, and recurrent non-accidental trauma was revealed. The results strongly advocate the need for early, interdisciplinary, and standardized forensic casework in the service of child protection and child victim justice.

Forensic Conclusion

The fused imaging, autopsy, histopathology, and external analysis methods provided compelling evidence of repeated non-accidental trauma. This highlights the abuse of children as forensic subjects and the work of forensic specialists as the backbone of a multidisciplinary team approach, a proven necessity for timely and rigidly devised protocols.

Explicit Acknowledgement of Limitations

The single-case design, the partial subjectivity of bruise dating, and the dependence on postmortem findings are the limitations of this case report. In environments with limited resources, access to sophisticated forensic tools may be limited as well. Broader multi-center studies with standardized methods are needed to improve diagnostic accuracy and policy relevance.

Conflicts of Interest

The authors report there are no competing interests to declare.

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Ethics approval and consent to participate

This study has been approved by the Ethics

Committee of the Faculty of Dentistry, Airlangga University, Indonesia. Ethics certificate No.: 0335/HRECC.FODM/III/2025. Clinical trial number: not applicable.

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