

The importance of optic nerve sheath hemorrhage as a postmortem finding in cases of fatal abusive head trauma: A 13-year study in a tertiary hospital



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ABSTRACT

Fatal abusive head trauma is a major cause of death in children and toddlers who suffer from cruel physical abuse. Postmortem differentiation of fatal abusive head trauma from accidental head trauma can be a complicated process. This consecutive case series study aimed to determine the role of subdural optic nerve sheath hemorrhage (ONSH) in 70 autopsy cases of children ≤ 3 years old in making this differentiation. The study took place over a 13 year period (between August 1st 2003 and July 31st 2016) at a tertiary hospital in Thailand. Eleven cases were diagnosed with fatal abusive head trauma and 10 were identified as being accidental closed head trauma cases. Bilateral retinal hemorrhage was noted in antemortem medical records in every hospitalized abusive head trauma case ($n = 10$). Upon autopsy, ONSH was observed in all 11 fatal cases of abusive head trauma (bilateral = 10 and unilateral = 1) but not in any cases of accidental head trauma (0/5). Subdural hemorrhage was found in 10 out of 11 abusive head trauma victims but not in any of the 10 with accidental head trauma. Other postmortem findings in abusive head trauma included subarachnoid hemorrhage (5/11), marked brain swelling (3/11), skull fracture (4/11) and brain contusion (1/11). This study suggests that ONSH, together with subdural hemorrhage, plays an essential role in an accurate postmortem diagnosis of fatal abusive head trauma. Therefore, an ocular investigation should be performed in all autopsy cases where child abuse is suspected and where there is no reliable history/witnesses, confession or antemortem ophthalmologic examination.

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1. Introduction

Physical child abuse is a major cause of death in infants and toddlers. Up to 80% of fatal child abuse cases are due to abusive head trauma [1–3]. The mechanism of injury in cases of abusive head trauma may result from severe rotational and translational acceleration due to vigorous shaking (non-contact force), direct impact (contact force), or a combination of both [2,4]. Generally, an initial given history in correlation with the mechanism of injury is usually inadequate and not reliable in most cases of child abuse. Thus, the diagnostic process of abusive head trauma can be very difficult when differentiating from accidental head trauma especially in cases

with combined rotational acceleration and direct impact force. In non-fatal abusive head trauma cases, the investigation is usually carried out by a collaborative team of child abuse pediatricians and other specialists, such as ophthalmologists, radiologists, neurosurgeons, psychologists, nurse practitioners, certified social workers and attorneys while forensic pathologists play an important role in fatal cases.

In suspected cases of child abuse, clinical diagnosis of abusive head trauma is generally based on a classic triad of findings: diffuse axonal injury (presenting with coma or death), subdural hemorrhage and/or subarachnoid hemorrhage and intraocular hemorrhage. However, in recent years there has been considerable debate over the efficacy of the triad in accurately identifying a child who suffers from vigorous shaking. Although presence of the triad has been accepted by a majority of physicians as a diagnostic criteria for abusive head trauma or shaken baby syndrome in children without a history of motor vehicle collision [5], there is also a wide range of other medical conditions presenting with the triad, for example,

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birth difficulties, coagulopathy, infections, metabolic disorders, severe hypoxia and seizures [6]. Recently, there is a systematic review based on 30 selected publications from the original search of 3773 that aimed to determine the diagnostic accuracy of the triad in detecting shaken baby syndrome [7]. The authors concluded that there was limited scientific evidence demonstrating the association between the triad or its individual components and traumatic shaking, and that there is insufficient scientific evidence to assess the diagnostic accuracy of the triad to identify traumatic shaking [7]. All the information mentioned above has raised serious concerns about the diagnostic tools that have been generally acceptable for establishing a diagnosis of abusive head trauma.

On the other hand, several studies [8–18] have described ocular findings in cases of child abuse, including intraocular lesions (retinal hemorrhage, circumferential retinal folds with macular schisis, peripheral circumferential retinal folds, peripheral retinoschisis and peripapillary scleral hemorrhage, intrascleral hemorrhage and vitreous hemorrhage) and optic nerve sheath hemorrhage (ONSH). Postmortem ocular and orbital examination in two studies [10,17] suggested that the orbital or optic nerve injury is more common in shaken baby syndrome than in cases of accidental head trauma. A systematic review [4] also demonstrated that ONSH is significantly more indicative of abusive head trauma than other causes of pediatric death.

However, at present there are still no standard criteria for postmortem diagnosis of abusive head trauma. The purpose of this report is to examine whether in cases of suspected child abuse ONSH has a role in postmortem determination of abusive head trauma.

2. Materials and methods

This is a consecutive case series study of ONSH in fatal abusive head trauma cases. All pediatric medicolegal related deaths aged under 3 years during a 13 year period (August 1st 2003–July 31st 2016) from the Department of Forensic Medicine, Chonburi Hospital, Ministry of Public Health, Thailand were included in the study.

The data were collected from autopsy reports, as well as from medical records in fatal cases which were admitted to the pediatric intensive care unit. Abusive head trauma cases were identified based on autopsy findings and clinical summary (by a multidisciplinary child protection team in cases being hospitalized before death) by having at least 2 of the following: (1) intracranial hemorrhage, (2) retinal hemorrhage, (3) marked brain swelling on neuroimaging or at autopsy, (4) inadequate history to explain the degree of head injury, and (5) confessions/reliable witnesses or child abuse being confirmed in legal proceedings.

Cases with fatal child abuse without severe brain parenchyma loss due to direct impact and fatal accidental closed head trauma were also retrieved based on the recorded cause of death, manner of death and legal findings as well as antemortem medical records and history, if applicable.

Demographic data and forensic postmortem examination, in particular any ocular investigation enabling the identification of ONSH, were carefully reviewed. ONSH was confirmed by either gross examination (Fig. 1) or histologic sections (Fig. 2).

Dissection technique for orbital exenteration was performed as described elsewhere [10]. Briefly, after removal of the brain, the

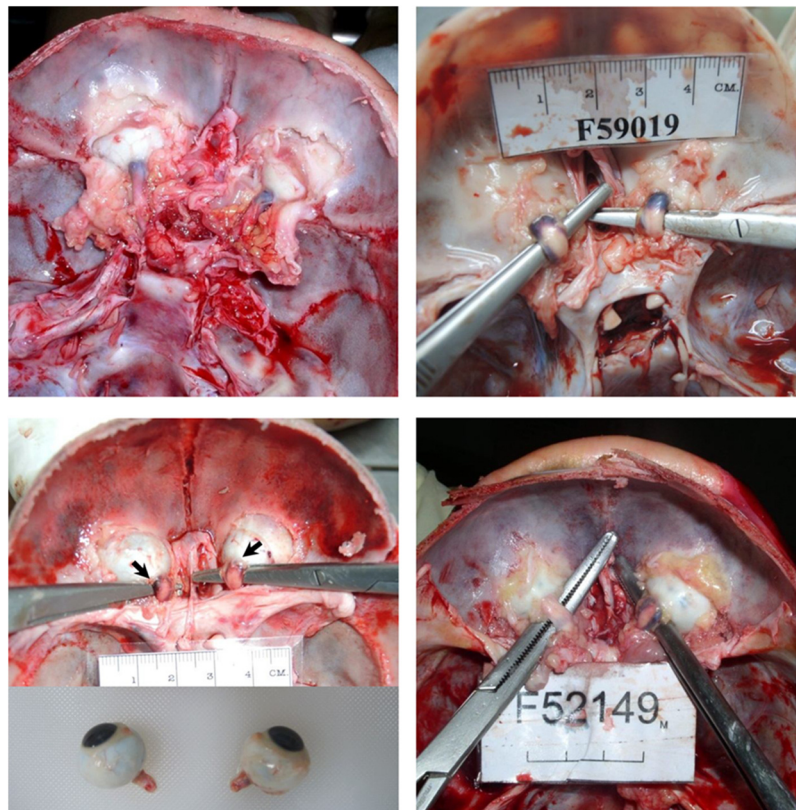


Fig. 1. Subdural optic nerve sheath hemorrhage (ONSH) in cases of fatal abusive head trauma.

Upper panel (cases #1 and #5 in Table 1) demonstrates bilateral ONSH that is clearly evident after brain removal. ONSH in AHT typically initiates from the attaching point to the eyeball (left lower panel, arrows), extends distally and does not connect to the intracranial subdural/subarachnoid hemorrhage. A careful *in situ* examination is crucially required in cases with minimal ONSH which is more difficult to evaluate in removed specimens (left lower panel, inset). Unilateral ONSH is observed in case #3 (Table 1) (right lower panel).

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