

The shaken baby syndrome: review of 10 cases

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Objective. To study the characteristics of the shaken baby syndrome from 10 cases in Hong Kong.

Design. Retrospective study.

Setting. Regional public hospital, Hong Kong.

Patients. Six boys and four girls (mean age, 0.54 years; range, 0.18-1.42 years) in whom the shaken baby syndrome was diagnosed between January 1994 and June 1998.

Main outcome measures. Clinical features at presentation, radiological findings, management, and outcome.

Results. All 10 patients presented with coma: the mean score on the Glasgow coma scale was 4.8 (range, 3-10). In all 10 cases, the history provided by the carers was incompatible with the patient's presentation. Nine patients presented with seizures. Retinal haemorrhages were detected in all patients, but peripheral signs of bruising were observed in only three. Acute subdural haematoma was found in eight patients; one of the remaining two children had subarachnoid and subdural haemorrhages, whereas the other had subarachnoid and intracerebral haemorrhages. Skeletal fractures were detected in two patients. The suspected abusers included either or both parents (n=3), childminders (n=3), and maids (n=2); the identity of the abusers were unknown in two cases. Prosecution by the police was initiated in three cases and two abusers were found to be guilty. Three children died of the abuse; the seven survivors had significant neurological handicaps.

Conclusion. Medical practitioners should be alert to the occurrence of abusive head injury in children. Peripheral signs are uncommon and a high degree of suspicion is needed for the management to be successful.

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Key words: Child abuse; Diagnosis, differential; Hematoma, subdural; Retinal hemorrhage

Introduction

Since the first Government report on child abuse in 1979, the significance of child abuse with regard to child health and interpersonal violence has drawn the attention of child protection agencies and health professionals.¹ Multidisciplinary services are now available to handle different categories of child maltreatment. The number of local cases reported by the Social Welfare Department has been increasing in the past few years.² The maltreatment of children is usually classified as taking the form of physical abuse, sexual abuse, neglect, or psychological abuse. Among these various forms of victimisation, physical abuse is the most readily recognisable and is the most

common means by which abused children die.³ In the United States, child abuse represents the leading cause of death in children who die of injury or trauma.⁴ Approximately 2000 children are killed annually in the United States as a result of maltreatment.⁴

The shaken baby syndrome as a form of child victimisation was first reported in 1971⁵ and the term was popularised following Caffey's report in 1972.⁶ The syndrome describes a constellation of symptoms and signs that result from the violent shaking of a young child. During the shaking, the child's head swings back and forth, with the neck acting as the fulcrum. A strong shearing force is generated and tears the incompletely myelinated axons in the parenchyma as well as the bridging veins over the dura. This outcome is often worsened by an accompanying impact on the infant's head. The shaking and impact result in an acute or subacute encephalopathy in the child, who is often admitted to hospital because of seizures and coma. The pathogenetic basis and clinical manifestations of the shaken baby syndrome have recently been reviewed.⁷ Cerebral oedema is common, but the occurrence of subdural and/or subarachnoid

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haemorrhage is more readily detectable by cerebral imaging. Retinal haemorrhages are often found during the bedside examination, and they are frequently the first clue to underlying abuse.

Despite its wide recognition in western countries, the shaken baby syndrome has rarely been reported in the local medical literature. In an extensive study on childhood head injury in Hong Kong, Hsiang et al⁸ noted a distinctive absence of abusive head trauma among 2785 subjects who were admitted to a regional hospital. In contrast, abusive head trauma is not a clinical rarity at the Tuen Mun Hospital (TMH).⁹ Because there seems to be a certain degree of misconception among childcare workers regarding the signs of the shaken baby syndrome (unpublished observation, 1998), we conducted a retrospective review of 10 cases of the shaken baby syndrome to define its characteristics.

Materials and methods

Records of all suspected or confirmed cases of shaken baby syndrome that were managed by the Department of Paediatrics at the TMH between January 1994 and June 1998 were reviewed. All cases had been subjected to social enquiry with or without police investigation according to the published procedures from the Social Welfare Department.¹⁰ The clinical features, radiological findings, management, and subsequent outcome were recorded. Reports from the social inquiry or post-mortem examination were included when applicable. The certainty of the diagnosis was arbitrarily classified as being either definitive if there was a confession by the abuser or if there were other signs of abuse, or as being highly probable if a clear account of the injury had not been given by the carer, or if

the mode of injury that had been described by the carer was not compatible with the severity of the trauma. Examples of highly probable cases of shaken baby syndrome include a history of fall that is not commensurate with the developmental stage of the infant, or a domestic fall from a height of 5 feet (1.5 m) or less when there is a fatal head injury associated with gross cerebral oedema and subdural haematoma.¹¹

Results

During the 4.5-year study period, 10 cases of shaken baby syndrome were identified from the medical records. The patients comprised six boys and four girls, and their mean age at presentation was 0.54 years (range, 0.18-1.42 years). All patients were admitted to the Tuen Mun Hospital because of acute encephalopathy that consisted of impaired consciousness; nine of the 10 patients also had seizures, whereas five of them had respiratory arrest. The mean score on the modified Glasgow coma scale¹² at the time of hospital admission was 4.8 (range, 3-10). All but one patient (patient 2) required intensive care, and eight of the children required ventilatory support using mechanical ventilation. Neurosurgical intervention, by way of evacuating a blood clot and/or monitoring the intracranial pressure, was required for seven patients. Three children died; the seven who survived had varying degrees of neurological handicap. Four of the 10 cases of shaken baby syndrome were classified as being definitive (patients 4, 7, 8, and 10); the remaining six were classified as being highly probable cases. The main clinical features are summarised in Table 1.

Despite the severe cerebral injury, peripheral signs of injury were uncommon in this group of patients. Physical examination showed bruising in three

Table 1. Summary of clinical features of patients with the shaken baby syndrome*

Patient No.	Age/sex (years)	Bone injury	Score on Glasgow scale	Seizures	Intracranial bleeding	Neurosurgery BH [†]	ICP [‡]	Suspected abuser	Alleged injury	Outcome
1	0.22/F	-	4	Yes	SAH [§] ; ICH ^{xx}	No	Yes	Unknown	None	Alive
2	0.21/F	-	10	Yes	aSDH [¶]	Yes	No	Unknown	None	Alive
3	1.42/M	-	3	Yes	aSDH	Yes	Yes	Childminder	Accidental fall from 4 feet	Died
4	0.19/M	Rib, ulna	3	No	aSDH	No	No	Maid	None**	Died
5	0.18/M	-	3	Yes	aSDH	No	Yes	Childminder	None	Alive
6	0.50/M	-	3	Yes	aSDH	No	No	Maid	None	Died
7	0.83/F	-	7	Yes	aSDH	No	No	Childminder	None**	Alive
8	0.81/M	-	5	Yes	aSDH	Yes	Yes	Father	Trip and fall**	Alive
9	0.41/M	-	4	Yes	aSDH	Yes	Yes	Either parent	None	Alive
10	0.61/F	Skull	6	Yes	SAH; saSDH ^{††}	Yes	Yes	Either parent	Fall from crib	Alive

* All patients had retinal haemorrhages at hospital admission

[†] BH burr hole drainage

[‡] ICP intracranial pressure monitoring

[§] SAH subarachnoid haemorrhage

^{xx} ICH intracerebral haemorrhage

[¶] aSDH acute subdural haematoma

^{††} saSDH subacute subdural haematoma

** Perpetrator subsequently admitted to shaking the child

children. In only one case (patient 8) was the bruising sufficiently characteristic of abusive marks. A skeletal examination was performed in all patients and two children were found to have abnormal results. A 2-month-old boy was found to have an old fracture of the left 10th rib and a metaphyseal fracture over the left ulna. A fracture of the left parietal bone was found in a 7-month-old girl.

The most common features that led to the diagnosis of abuse were retinal haemorrhage, as detected by fundoscopy, and intracranial bleeding, as detected by computed tomography. Retinal haemorrhages were seen in all 10 patients. Acute subdural haematoma was the most frequent form of intracranial bleeding and was found in eight of the patients. In one of the remaining two children, there were subarachnoid and intracerebral haemorrhages; in the other, there were subarachnoid and subacute subdural haemorrhages. Radiological features of diffuse cerebral hypoxia (ie areas of hypodensity) were also detected for four patients. Small non-haemorrhagic lesions, which were consistent with shearing injuries or diffuse axonal injury, were found in the magnetic resonance images of two children. Laboratory investigations were usually non-specific, but their results helped exclude other conditions. The patients were often anaemic; the mean haemoglobin level was 83 g/L (range, 67-105 g/L). Coagulation screening gave normal results for nine patients. The remaining patient (patient 4)—a 2-month-old boy—had a transiently prolonged prothrombin time (International Normalized Ratio, 1.9); his maid subsequently admitted to shaking him to death.

The suspected abusers were identified in eight cases and consisted of either or both parents (n=3), female childminders (n=3), and maids (n=2). In the remaining two cases, multiple carers were involved and the onset of illness was nebulous. No explanation for the injury had been given in seven cases, and minor falls had been reported in the remaining cases. Three of the abusers subsequently admitted to shaking the children. In addition to the medical intervention given, social inquiries had been initiated according to published procedures issued by the Social Welfare Department.¹⁰ Multidisciplinary case-conferences were held for nine of the victims. Prosecution by the police followed in three cases and the perpetrators in two of the cases (patients 4 and 8) were found to be guilty.

Discussion

Child abuse is increasingly being recognised as an important social and child health issue in Hong Kong.

An annual incidence of 0.33 per 1000 children younger than 15 years was reported by the Social Welfare Department in 1998.² Their report, however, did not describe the severity and variety of the injuries, and the quoted incidence is likely to be an underestimate. At the TMH, which serves a population of approximately 800 000, more than 50 cases of suspected child abuse are evaluated each year.⁹ Because of the selective bias, the majority of cases that are encountered in the hospital are classified as cases of physical abuse. Serious injuries are common—for example, in 1997, skeletal fractures were encountered in more than 10% of the confirmed cases.¹³ In addition, abusive head injury or the shaken baby syndrome occurred in 5% of the cases and accounted for all the deaths that occurred among the abused children in 1997.¹³ Based on a childhood population of 160 000 that is served by the TMH,¹⁴ the findings in this study indicate that the annual incidence of the shaken baby syndrome is 1.4 per 100 000 children younger than 15 years. Comparative data from other countries are lacking,^{3,7} and incidences are often based on the rates of admission to a specific institution.⁷

The clinical features and biomechanical characteristics of the shaken baby syndrome have been previously well described.^{7,15} The acute or subacute onset of coma, convulsion, or signs of increased intracranial pressure in a young child, when there is no obvious aetiology, should prompt the clinician to make the possible diagnosis of shaken baby syndrome. The finding of retinal haemorrhages often gives an important clue to the correct diagnosis. Subdural and/or subarachnoid haemorrhage, especially in the interhemispheric region, as detected by computed tomography scanning, is a characteristic of the syndrome.¹⁶ For a child who does not survive, the post-mortem finding of diffuse axonal injury would add substantially to the diagnosis.¹⁷ Similar clinicopathological features may be found in patients who have sustained injuries from high-speed motor vehicle accidents.¹¹

Biomechanical studies have demonstrated that a young infant's skull is well adapted to sustain mild to moderate impacts in terms of protecting the skull's contents.^{7,15} Such translational impacts may fracture the skull and bruise the underlying brain locally. On the other hand, angular forces that have sudden acceleration and deceleration result in the exertion of an intense shearing force on the developing brain. Such forces are reproducible by vigorous shaking, often in combination with some degree of impact. Unmyelinated axons and bridging veins that are situated over the dura can be torn. Although the subdural haematoma is

often the more discernible event clinically, the diffuse axonal injury and associated cerebral oedema are the most detrimental events that occur during the injury.

Conditions that mimic the shaken baby syndrome are generally easy to distinguish.⁷ Systemic bleeding disorders such as haemophilia and thrombocytopenia have been associated with acute intracranial bleeding and retinal haemorrhages.¹⁸ Bleeding due to Vitamin K deficiency—previously known as haemorrhagic disease of the newborn—may occur in an infant who has not received appropriate prophylaxis.¹⁹ Acute infections and infiltrative disorders of the central nervous system have also been reported to have a similar symptomatology to that of the shaken baby syndrome; these include falciparum malaria and blood dyscrasias.²⁰ Taking a thorough medical history, and performing a physical examination and simple laboratory investigations are generally sufficient to exclude these conditions.

The most important differential diagnosis of the shaken baby syndrome is accidental or unintentional injury. The occurrence of acute subdural haematoma has been found to be rare among large series of paediatric patients who have sustained head injury.⁸ While acute epidural haematoma has been recognised as being an uncommon consequence of short-distance falls due to unintentional injury,²¹ it is unknown whether similar falls would produce acute subdural haematoma in children. Reports of paediatric head injury for which an evaluation of child abuse has not been conducted should be interpreted with caution. Chadwick et al²² studied 317 children who had been admitted to a children's trauma centre with a history from the carer that the child had fallen. When the histories were accepted without question, it was found that children who had fallen from a height of 4 feet

(1.2 m) or less were more likely to die compared with those who had fallen from a height of 10 feet (3 m) or more (7/100 versus 1/117, respectively). All fatalities due to short-distance falls involved other factors, which indicated that their histories had been fabricated. In contrast, when witnessed and corroborated falls were studied, serious head injuries were not found in children who had fallen from a height of less than 10 feet.²³ Similar studies in 180 children who had fallen from hospital cribs also support this finding.^{24,25}

Another controversy is whether or not retinal haemorrhage can occur after a child receives cardiopulmonary resuscitation (CPR). Previous reports of retinal haemorrhage following CPR have often ignored the possibility of child abuse in the seriously injured children. It is a common observation that retinal haemorrhage can occur after severe compression injury to the chest (Purtscher's disease or angiopathic retinopathy)²⁶—for example, crush injuries that occur due to trampling during riots, or after a child's chest has been driven over by a motor vehicle. Table 2 shows the occurrence of paediatric retinal haemorrhage from previous studies.²⁶⁻³¹ Systematic literature reviews that included studies of intensive care admissions and post-mortem series suggest that there is a real but rare association between CPR and retinal haemorrhage.^{20,26} Child abuse, however, is a far more common predisposing factor.^{20,27,31} Thus, inflicted head injury should be excluded before retinal haemorrhage can be ascribed to CPR.

This study shows that abusive head trauma occurs in Hong Kong at an appreciable frequency. The diagnosis of the shaken baby syndrome should be contemplated for any young child who presents with signs and symptoms of severe head injury, as advocated by Siu et al in their report of three cases.³² The diagnosis

Table 2. The occurrence of retinal haemorrhage in relation to cardiopulmonary resuscitation and head injury

Study	Study group	Occurrence of retinal haemorrhage
Goetting and Sowa, ²⁶ 1990	Children without abuse after receiving cardiopulmonary resuscitation	2/20
Buys et al, ²⁷ 1992	Children younger than 3 years after sustaining head injury	0/75 cases of accidental injury, 3/3 cases of inflicted injury, 0/1 case of indeterminate injury
Elder et al, ²⁸ 1991	Accidentally injured children (prospective study)	0/25
Johnson et al, ²⁹ 1993	Seriously and accidentally injured children	2/140
Gilliland and Luckenbach, ³⁰ 1993	Children who received cardiopulmonary resuscitation (post-mortem study of 169 cases)	60 cases of known predisposing cause, 1 case of suspected abuse
Kanter, ³¹ 1986	Six children who received cardiopulmonary resuscitation	4 cases of confirmed abuse, 1 case of motor vehicle accident, 1 case of hypertensive encephalopathy

should be established on a careful analysis of physical and radiological findings, a cautionary interpretation of the history provided by the carer, and often a social inquiry to understand the family background and past history of abuse. For cases of inflicted trauma, the initial account given by the carer is often not reliable, and peripheral signs of abuse are often lacking. In cases where contradicting clues are present, the clinician should interpret each and every factor based on recently published evidence.

Finally, at least 50% of the victims in this series were abused by carers other than their parents. In contrast, babysitters comprised only 21.2% of the abusers in a Caucasian series reported by Starling et al.³³ Thus, maids and babysitters represent an additional target at which preventive measures could be directed.

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