

Original Article

## Unexplained subdural hematoma in young children: Is it always child abuse?

EVA LAI WAH FUNG,<sup>1</sup> RITA YN TZ SUNG,<sup>1</sup> EDMUND ANTHONY SEVERN NELSON<sup>1</sup> AND WAI SANG POON<sup>2</sup>

*Departments of <sup>1</sup>Paediatrics and <sup>2</sup>Surgery, Faculty of Medicine, Prince of Wales Hospital, The Chinese University of Hong Kong, Shatin, Hong Kong*

### Abstract

**Background:** In the published reports of the developed society, subdural hematoma and/or retinal hemorrhages, in the absence of documented history of major trauma, should be considered diagnostic of child abuse. Many people used the above criteria for diagnosis, but subsequently found that retinal hemorrhages were more common in non-accidental injuries (NAI). To what extent is the proposed pathognomonic association between unexplained subdural hematoma/retinal hemorrhages and child abuse a self-fulfilling prophecy?

**Methods:** Clinical details of nine children under 2 years with unexplained subdural hematoma admitted to Prince of Wales Hospital between 1995 and 1998 were reviewed.

**Results:** Four had no other physical signs of injury, five had retinal hemorrhages and one had multiple bruises over the body. Following multidisciplinary case conferences for seven children, a diagnosis of NAI was concluded in four cases, but in no case could the abuser be definitely identified. Clinical outcome was poor with seven children showing either profound disability ( $n = 5$ ) or evidence of developmental delay ( $n = 2$ ).

**Conclusion:** In this series, NAI were not established in three of the seven cases. Did we underdiagnose child abuse in these cases? Despite a magnitude of opinion to the contrary, the issue of whether 'trivial' head injury can cause subdural hemorrhages and/or retinal hemorrhages is yet unresolved. Clearly much more information on this very sensitive and serious issue is required and these data should be collected with an open mind.

**Key words** accidental injury, child abuse, retinal hemorrhage, subdural hemorrhage.

Most studies attribute unexplained subdural hematoma or hemorrhage in infancy to non-accidental injury (NAI).<sup>1–5</sup> It suggested that in the absence of an underlying cause, such as a coagulopathy and without other accountable substantial trauma, the presence of subdural hemorrhage is indicative of child abuse and thorough investigation is required.<sup>6</sup> Subdural hematoma, retinal hemorrhage, fracture and a previous history of child abuse in the family are considered to be features of shaken baby syndrome.<sup>2,5,7,8</sup> Two recent large case series have concluded that retinal hemorrhage, in the absence of history of major trauma (gun shot wound, motor vehicle accident) is virtually diagnostic of child abuse.<sup>9,10</sup> Despite

these strong views there is still some debate as to how much a force is required to cause subdural hemorrhage,<sup>1</sup> and reports from Japan have suggested that infantile subdural hematoma is unlikely to be due to child abuse.<sup>11</sup> This condition is a very emotive one with significant implications at many levels for the child and their families. It presents a challenge for doctors, child welfare investigators and the courts, who are increasingly obliged to establish a diagnosis of child abuse. The magnitude of the problem of shaken baby syndrome in Hong Kong is still uncertain.<sup>12</sup> Following the admission of five children with unexplained subdural hematoma to the Prince of Wales Hospital during 1998, we reviewed all cases presented during the previous 4 years.

Correspondence: ELW Fung, Department of Paediatrics, The Chinese University of Hong Kong, 6/F Clinical Science Building Prince of Wales Hospital, Shatin, Hong Kong.  
Email: b300875@mailserv.cuhk.edu.hk

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### Methods

Identifiers of patients with the following ICD-9 discharge diagnoses were obtained from Paediatric Department audit database: 995.50 (child abuse, unspecified), 995.54 (child

**Table 1** Details from multidisciplinary case conferences for suspected NAI

Case number	Father's age	Father's employment	Mother's age	Mother's employment	Care-taker	Number of siblings	Conclusion in case conference	Basis for case conference conclusion
1	41	Full time	36	Full time	Foreign maid/mother	1	NAI	Typical injury pattern.
2	–	–	20	Unemployed	Mother	0	NAI	Typical injury pattern + unfavorable social environment (mother drug addict).
3	37	Full time	31	Housewife	Mother	2	NAI	Typical injury pattern.
5	33	Full time	25	Full time	Maternal aunt	2	NAI	Typical injury pattern + external wound.
6	41	Full time	34	Housewife	Mother/paternal grandmother	2	Not NAI	There may be any accident (fall), followed by parents' shaking to wake up the baby, no intention of abuse.
8	33	Full time	29	Full time	Paternal grandaunt	1	Not NAI	Nothing suspicious in the history and social setting.
9	37	Full time	37	Full time	Foreign maid	0	Not NAI	Highly suspicious for NAI but not established, will follow up the family.

NAI, non-accidental injury.

physical abuse), 995.55 (shaken infant syndrome), 432.1 (subdural hemorrhage) and 852 (subarachnoid, subdural and extradural hemorrhage, following injury).<sup>13</sup> Neurosurgical operation logbooks for the period January 1995 to December 1998 were also reviewed. The discharge summaries or case files of these patients were screened to identify patients with subdural hematoma (acute or chronic) confirmed by computed tomography (CT) and/or magnetic resonance imaging (MRI). Children with subdural hemorrhage secondary to infection or neurosurgical intervention were excluded.

Details of the clinical presentation, medical and social investigations, treatment and outcome were abstracted. Particular attention was paid to any recorded associated injury (bruises and fracture), the presence of retinal hemorrhages, evidence of clotting dysfunction (including bleeding tendency in newborns secondary to vitamin K deficiency) and results of metabolic screening. The minutes of multidisciplinary case conferences for suspected child abuse were reviewed ( $n = 7$ ). The social circumstances including the parents' age and occupation (full time/part-time/unemployed), care-taker and reasons for drawing the conclusion in the case conferences are listed in Table 1.

## Results

Table 2 shows the nine children with subdural hematoma identified during this 4-year period – one case each in 1995 and 1997, two in 1996 and five in 1998. The children's age ranged from 1 to 24 months, with a mean age of 8.3 months. All patients had undergone urgent CT brain scans and two had MRI brain scans performed. Seven of the nine cases underwent multidisciplinary case conferences for suspected child abuse. All of these cases had normal skeletal surveys and coagulation screens. Ophthalmological examination, by an ophthalmologist, was performed in eight patients and retinal hemorrhages were detected in five. Multiple skin bruises were noted in one patient and an occipital hematoma in another. All patients required neurosurgical intervention. In none of the cases reviewed was there a definite history of shaking or previous history of physical abuse (in the patient or within the same family). Four cases had a history of minor injury before presentation. In none of the four cases concluded to be due to child abuse was the perpetrator of the presumed abuse identified. Child abuse was considered unlikely in two of the cases that did not have multidisciplinary

**Table 2** Details of nine children admitted to the Prince of Wales Hospital with subdural hemorrhage

No.	Sex	Age (months)	Care-giver	Presenting features	History of trauma	Other signs of injury	CT/MRI findings	Case conference	Outcome
1	M	5	Maid	Convulsion (facial prior petechiae 2 weeks to admission)	Nil	Right retinal hemorrhage	Acute left subdural hematoma	NAI, no abuser identified	Spastic quadriplegia, epilepsy, retinal detachment
2	M	7	Mother (drug addict)	Status epilepticus	Three recent falls	Nil	Bilateral extensive subdural effusions	NAI, no abuser identified	Alternative care, right lower limb weakness, delayed development, left convergent squint
3	M	9	Maid	Inconsolable crying, twitching of limbs	Fall from sibling's arms	Flamed shape subretinal hemorrhage	Subarachnoid hemorrhage, subdural hematoma	NAI, no abuser identified	Spastic quadriplegia
4	M	1	Mother/ aunt	Fever, twitching of limbs	Nil	Small left retinal hemorrhage	Fronto-parietal hematoma, left chronic subdural	Nil	Spastic quadriplegia, global delay
5	M	3	Aunt	Decreased level of consciousness	Nil	Multiple bruises	Bilateral chronic subdural hematoma	NAI, no abuser identified	Borderline developmental delay
6	M	10	Mother	Convulsion, loss of consciousness	Fall on occiput while standing	Bilateral extensive retinal hemorrhage	Acute subdural	Not NAI	No obvious delay
7	M	14	Mother	Decreased consciousness	Fall from chair	Occipital hematoma	Acute subdural and extradural hematoma	Nil	Right upper limb weakness and developmental delay
8	M	2	Mother	Fever, decreased consciousness	Nil	Nil	Bilateral subdural hematoma	Not NAI	Spastic quadriplegia
9	F	24	Maid	Convulsion	Nil	Retinal hemorrhage	Acute SDH	Not NAI	Spastic quadriplegia

Coagulation screen undertaken were all normal. CT, computed tomography; MRI, magnetic resonance imaging; NAI, non-accidental injury; SDH, subdural hematoma.

case conferences. Seven of the patients had significant sequelae, five developed spastic quadriplegia and two developed developmental delay.

## Discussion

This review highlights two areas of concern. First, the apparent increase in cases of subdural hematoma diagnosed during 1998 and second, whether a greater proportion (or even all) of the cases should have been classified as being due to child abuse. The Social Welfare Department of the Hong Kong Government maintains statistics on NAI, but does not provide details of the type of physical injury. These data show a small but steady increase in reported NAI in Hong Kong during the past 3 years. The annual incidence of child abuse in children younger than 15 years was 0.33 per

1000 in 1998.<sup>14</sup> This increase is likely to be explained, in part, by the increased awareness of NAI among medical staff and the community. However, the apparent increase in cases of subdural hematoma during 1998 is unlikely to be due to an increased awareness of shaken baby syndrome and NAI. This would be anticipated that children experiencing subdural hematoma would be consistently identified as such, irrespective of whether the precipitating cause was thought to be due to NAI or not. All such cases would have significant neurological symptoms and CT brain scans were available throughout the study period. Being a retrospective study, it is possible that some cases in the earlier years may not have been identified. Although the audit system should capture all discharge diagnoses, it is possible that coding was not always completed correctly. Review of the neurosurgical logbooks would only detect infants undergoing surgery, but it is unlikely that any change in the frequency of neurosurgical

intervention would have occurred in this time period. Finally, the apparent increase could be real or due to chance alone. Detailed prospective study of all pediatric head injury in Hong Kong would be required to clarify this.

Was NAI under- or overdiagnosed in this series? Similar to previous reports, the presenting features of our patients were varied. Some presented with altered level of consciousness, generalized or focal convulsion, or motor deficit, whereas others had non-specific signs and symptoms such as irritability, repeated vomiting, bulging fontanelle or rapidly enlarging cranial vault. Diagnoses in all cases were confirmed by CT brain scan or MRI. The CT brain scan is useful in assessing acute unstable patients, while MRI is good for assessing cortical contusion, small subdural hematoma or diffuse axonal injury.<sup>15</sup> The mechanism of subdural hematoma is postulated as rupture of one or more of the delicate bridging veins that run from the cerebral cortex to the venous sinuses.<sup>1</sup> Reported causes include trauma (non-accidental/accidental), bleeding tendency, birth trauma, cerebral atrophy (e.g. in Glutaric aciduria type 1) and thrombosis of dural venous sinus secondary to dehydration.<sup>16-20</sup> Bleeding tendency and metabolic defect were not detected in any of our cases. Therefore, many would consider that as the purported injuries in our cases were relatively minor or absent, the presence of subdural hematoma and/or retinal hemorrhages should have made the diagnosis of NAI highly likely.<sup>6</sup> Seven of the nine cases were thoroughly investigated for the possibility of NAI, but only two had other external signs of injury and none had fractures on skeletal survey. This appears to differ from another study in which 39.4% of patients had other evidence of abuse (e.g. torn frenulum, adult bites, bruising, etc.) and 59.3% had fractures on skeletal survey. However, the clinical outcome of patients in this study was also poor with most being left severely handicapped.<sup>6</sup>

Two recent reviews strongly argue for the conclusion that retinal hemorrhages in the absence of major trauma should be considered diagnostic of child abuse.<sup>9,10</sup> One report examined 1997 injuries in children under 4 years and noted that 28.7% of abused children had retinal hemorrhages, compared with 0.07% of non-inflicted injuries.<sup>9</sup> The classification of the children as abused was made by the treating hospital and was not questioned by the authors. Detailed criteria were not listed. The other report reviewed 287 head injuries over a 10-year period. A total of 18/54 children with injuries due to abuse had retinal hemorrhages, compared with 5/233 accidental injuries.<sup>10</sup> The classification of the children as abused was on the basis of several criteria, including *no history accounting for patient's serious head injury*, physical findings consistent only with abusive injuries (pattern, old and new lesions, location, etc). It is therefore not clear to what extent these conclusions are a self-fulfilling prophecy, that is, defining child abuse on the basis of subdural

hemorrhage and retinal hemorrhage when there is '*no history accounting for patient's serious head injury*,' and then concluding that there is a high incidence of retinal hemorrhage in child abuse.

Current practice in Hong Kong is for a multidisciplinary case conference to be organized if there is any suspicion of NAI. Members involved include pediatricians, social workers, police, other medical subspecialties (neurosurgeons, psychiatrists) and schoolteachers. The team will discuss the findings of their investigations and conclude whether NAI is established or not and then decide on the future welfare plan for the child. Although the diagnosis in four of the seven cases investigated with a case conference were considered to be due to NAI, there was proof of other injury in only one. None of the perpetrators was clearly identified and no legal proceedings were taken. A further three cases were considered not to be NAI after the case conference, despite the fact that no clear explanation was found for the subdural hemorrhage and the fact that two had evidence of retinal hemorrhages. Two patients were not investigated for NAI. One child had a history of a fall from a chair and evidence of an occipital hematoma. The other child had no history of injury, but evidence of a small retinal hemorrhage. In reaching conclusions at a case conference, problems arise when there is different opinion among the members of the team. However, if all members of the team are 'educated' to the fact that the presence of subdural hematoma and/or retinal hemorrhage with '*no history accounting for patient's serious head injury*', is diagnostic of child abuse, then all cases will increasingly be so classified irrespective of what the caregivers say. For some this may mean a lengthy term in jail.

A common clinical scenario in our cases was that upon repeated history, the parents and caregivers are found to be very concerned and no suspicious circumstances can be identified, and yet because the injury is either stated to be trivial or non-existent, a diagnosis of child abuse must be considered. This is illustrated in the case where a 10-month-old boy slipped and fell and hit his occiput on the ground covered by a thin mattress. This was followed by loss of consciousness and a brief convulsion. Urgent CT brain showed acute subdural hematoma and ophthalmological examination revealed bilateral extensive retinal hemorrhage that was considered to be highly suspicious for NAI. The social setting was good. After repeated interviews with the mother there were no findings considered suspicious. The family was very cohesive with good social support and the mother was mature and emotionally stable. Considerable debate ensued between the neurosurgeons, pediatricians, police and social worker as to whether the apparent trivial injury could produce such extensive damage. A conclusion was reached that this was not NAI, but had the mother been a drug addict or a single mother would the conclusion have

been different? Young parents, unstable family situations, low socioeconomic status and disability of the child are well known risk factors for NAI.<sup>21,22</sup> Yet, the social environment in Hong Kong is very different to that of many developed countries. The rate of teenage pregnancy (15–19 years) is very much lower in Hong Kong (6/1000)<sup>23</sup> than in the US (126/1000).<sup>22</sup> In Chinese culture and tradition, the extended family offer much support and help in childcare, which will help to relieve the pressure on the mother.

Aoki and Masuzawa in Japan described 'infantile acute subdural hematoma' following apparent minor head trauma and retinal hemorrhages were commonly associated.<sup>11</sup> This was suggested to be a different entity from 'acute subdural hematoma' due to high-grade impact injury seen at all ages. However, the existence of this infantile form of subdural hematoma has been questioned by western neurosurgeons who suspect that child abuse is being underdiagnosed.<sup>24</sup> Further study by Aoki's group showed that retinal hemorrhage and subdural hematoma without external signs of injury in Japan is usually attributed to accidental, trivial head injury, whereas subdural hemorrhage associated with external signs of trauma to the face or head were commonly found in cases of genuine child abuse.<sup>25</sup> In particular it was noted that retinal hemorrhages were not present in two of five cases of genuine NAI. Is shaken baby syndrome overdiagnosed in the west and underdiagnosed by Aoki's group in Japan, or are there genuine differences in the incidence and/or mechanism of subdural hemorrhage between the two regions? The lack of other evidence of abuse and the documentation of minor trauma in most of our cases indicates that the Aoki's experience is more similar to ours.

Do we really have sufficient knowledge of the magnitude of force required to result in such injuries and do we know the various modifiers that may influence this process? It is still uncertain as to how severe an injury must be to cause intracranial bleeding.<sup>26</sup> Clearly vast numbers of children experience a range of mild head injuries with no ill effects. It is perfectly feasible that in a very small proportion, because of the influence of one or more other factors, subdural hematomas and retinal hemorrhages develop after minor injuries or apparent casual shaking.<sup>1,20</sup> For example, in the presence of external hydrocephalus a minor injury may result in both subdural hematoma and retinal hemorrhages.<sup>20</sup>

In the light of western experience, we arranged case conferences in most cases of unexplained subdural hematomas in infants, even in the absence of any history suspicious of NAI. The police are usually involved and these investigations are extremely stressful for the family, especially when already shocked by having a critically ill infant with a high probability of long-term disability. By following this course of action we run the risk of damaging the lives of innocent families, in our attempt to prevent further injury to this or other children. Families wrongly accused lose more than

their child does, while a child returned in error to an abusing home may lose its life.<sup>1</sup> Some would argue that all nine of our cases should have been classified as NAI. Conversely, three of the four cases classified as NAI had no other injury or other evidence of NAI. Did we overdiagnose child abuse in these three or underdiagnose it in the other five children? Although limited by a small number of patients, our qualitative data can give insight that may be lost in larger case series. We believe that, despite a magnitude of opinion to the contrary, the issue of whether 'trivial' head injury can cause subdural hemorrhage and retinal hemorrhages is still unresolved. Clearly much more information on this very sensitive and serious issue is required, and these data should be collected with an open mind.

## References

- 1 Wilkins B. Head injury – abuse or accident? *Arch. Dis. Child.* 1997; **76**: 393–6.
- 2 Ludwig S, Warman M. Shaken baby syndrome: a review of 20 cases. *Ann. Emerg. Med.* 1984; **13**: 104–7.
- 3 Duhaime AC, Christian CW, Rorke LB, Zimmerman RA. Nonaccidental head injury in infants – the 'shaken-baby syndrome'. *N. Engl. J. Med.* 1998; **338**: 1822–9.
- 4 Billmire ME, Myers PA. Serious head injury in infants: accident or abuse? *Pediatrics* 1985; **75**: 340–2.
- 5 Jayawant S, Rawlinson A, Gibbon F *et al.* Subdural haemorrhages in infants: Population based study. *BMJ* 1998; **317**: 1558–61.
- 6 Lloyd B. Subdural haemorrhages in infants. Almost all are due to abuse but abuse is often not recognised. *BMJ* 1998; **317**: 1538–9.
- 7 American Academy of Pediatrics Committee on Child Abuse and Neglect. Shaken baby syndrome: Inflicted cerebral trauma. *Pediatrics* 1993; **92**: 872–5.
- 8 Johnson DL, Braun D, Friendly D. Accidental head trauma and retinal hemorrhage. *Neurosurgery* 1993; **33**: 231–4.
- 9 DiScala C, Sege R, Li G. Child abuse and unintentional injuries. *Arch. Pediatr. Adolesc. Med.* 2000; **154**: 16–22.
- 10 Recce RM, Sege R. Childhood head injuries. *Arch. Pediatr. Adolesc. Med.* 2000; **154**: 11–15.
- 11 Aoki N, Masuzawa H. Infantile acute subdural hematoma. Clinical analysis of 26 cases. *J. Neurosurg.* 1984; **61**: 273–80.
- 12 Hsiang JN, Goh KY, Zhu XL, Poon WS. Features of pediatric head injury in Hong Kong. *Childs Nerv. Syst.* 1996; **12**: 611–14.
- 13 Leung DT, Tseng RY, Davies DP. Setting up a clinical audit of paediatric morbidity in Hong Kong: Some early experiences. *Aust. Paediatr. J.* 1987; **23**: 111–13.
- 14 Social Welfare Department. Child protection registry. Statistical report 1997. Hong Kong Government, Hong Kong, 1998.
- 15 Sklar EM, Quencer RM, Bowen BC, Altman N, Villanueva PA. Magnetic resonance applications in cerebral injury. *Radiol. Clin. North Am.* 1992; **30**: 353–66.
- 16 Hymel KP, Abshire TC, Luckey DW, Jenny C. Coagulopathy in pediatric abusive head trauma. *Pediatrics* 1997; **99**: 371–5.

- 17 Osaka H, Kimura S, Nezu A, Yamazaki S, Saitoh K, Yamaguchi S. Chronic subdural hematoma, as an initial manifestation of glutaric aciduria type-1. *Brain Dev.* 1993; **15**: 125–7.
- 18 Hoffmann GF, Naughten ER. Abuse or metabolic disorder? *Arch. Dis. Childh.* 1998; **78**: 399.
- 19 Woelfle J, Kreft B, Emons D, Haverkamp F. Subdural hemorrhage as an initial sign of glutaric aciduria type 1: A diagnostic pitfall. *Pediatr. Radiol.* 1996; **26**: 779–81.
- 20 Piatt JH. A pitfall in the diagnosis of child abuse: external hydrocephalus, subdural hematoma, and retinal hemorrhages. *Neurosurgical Focus* 1999; **7**: article no 4.
- 21 Sills JA, Thomas LJ. Non-accidental injury: A two-year study in central Liverpool. *Dev. Med. Child Neurol.* 1977; **122**: 259–62.
- 22 National Center for Health Statistics. Advance report of final monthly statistics. 1990 Monthly Vital Statistics Report. US Dept of Health, Education, and Welfare, Hyattsville, 1993; 41: 21, 31.
- 23 Grant C, Yuen P. The Hong Kong Health Care System. Southwood Press Ltd, Sydney, 1998.
- 24 ReKate HL. Subdural hematomas in infants. *J. Neurosurg.* 1985; **62**: 316–17.
- 25 Aoki N, Masuzawa H. Subdural hematomas in abused children: report of six cases from Japan. *Neurosurgery* 1986; **18**: 475–7.
- 26 Gayle MO, Kisson N, Hered RW, Harwood-Nuss A. Retinal hemorrhage in the young child: a review of etiology, predisposed conditions, and clinical implications. *J. Emerg. Med.* 1995; **13**: 233–9.