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Retinal haemorrhage in accidental head trauma in childhood

J. E. ELDER,[1] R. G. TAYLOR[2] and G. L. KLUG[3]

[1]*Departments of Ophthalmology,* [2]*General Surgery and* [3]*Neurosurgery, Royal Children's Hospital, Parkville, Victoria, Australia*

Abstract Twenty-five children (age range 1.2–14.5 years) who sustained accidental head injury requiring admission to hospital were prospectively examined for evidence of retinal haemorrhage. In no case were retinal haemorrhages detected. It is suggested that accidental head injury seldom results in retinal haemorrhage and that the finding of retinal haemorrhage in a child with a head injury should prompt suspicion of abuse.

Key words: accidental injury; child abuse; children; head injury; retinal haemorrhage.

Retinal haemorrhage is a well recognized manifestation of child abuse[1–5] and is commonly seen as part of the shaken baby syndrome.[6–9] The diagnosis of child abuse needs to be considered in children with retinal haemorrhages. However in such situations the history given of the mechanism of injury is often either lacking, incomplete or untrue.[9,10] On occasions it is alleged that the injuries arose as the result of accidental blunt head trauma.[1,2,5]

The generation mechanism of retinal haemorrhages in the shaken baby syndrome is uncertain.[2,4,5,11] Thus, it may be difficult for a physician to state confidently whether the haemorrhages in a particular child are, or are not, consistent with an alleged history of head trauma.

The following study was undertaken to determine the incidence of retinal haemorrhages in children known to have sustained accidental head trauma.

METHODS

All children under the age of 15 years admitted to the Royal Children's Hospital, Melbourne with a significant head injury over a 3 month period from January to March 1989 were considered eligible for inclusion in the study. A significant head injury was defined as injury which resulted in loss of consciousness, confusion or an obtunded mental state. Children with multiple injuries including head injury were not excluded.

The severity of the head injury was graded by the Glasgow Coma Scale.[12] The initial coma score determined by the Mobile Intensive Care Ambulance crew at the accident site or the score on admission to the casualty department of the hospital was used. The general severity of the injury or injuries was graded using the Injury Severity Score.[13]

Correspondence: J. E. Elder, Department of Ophthalmology, Royal Children's Hospital, Flemington Rd., Parkville, Victoria 3052, Australia.

J. E. Elder, MB, BS, FRACO, Ophthalmologist. R. G. Taylor, MB, BS, FRACS, Paediatric Surgeon. G. L. Klug, MB, BS, FRACS, Director, Department of Neurosurgery.

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The mechanism of injury was ascertained by review of the hospital record or by interview of the child's parents or guardians. Children suspected of having sustained non-accidental injury were excluded.

All children were examined as soon as practicable following admission by one examiner. The examination included external inspection of the eye and adnexa (looking for signs of direct ocular trauma) and indirect funduscopy after dilating both pupils with 1% tropicamide. No patient was examined until the neurosurgeon responsible considered them neurologically stable.

The rate of resolution of retinal haemorrhages induced by trauma, either direct or indirect, is variable. It is well known that the more minor degrees of retinal haemorrhage induced by birth trauma resolve within a week.[14–16] Retinal haemorrhages caused by abuse may take as long as 11 weeks to clear.[17] To minimize the risk of missing minor haemorrhages, no child was entered into the study if examination had to be delayed more than a week after injury.

This project was approved by the Ethics Research Committee of the Royal Children's Hospital. Written informed consent was obtained from the parents or guardians prior to the examination being undertaken.

RESULTS

Twenty-five children were examined. The age range was 14 months to 14½ years with the median age being 5.6 years (see Table 1 for breakdown of age groups). All children were examined within 6 days of injury and 72% were examined within 3 days of injury.

Table 1 Age of children examined

Age (years)	Number (%)
<2	4 (16)
2–<5	8 (32)
5–<10	5 (20)
10–<15	8 (32)

Nature of injury

Sixteen (64%) children sustained closed head injuries with no associated skull fracture. The management of the head injury in this group was by observation. One child in this group had a haemopneumothorax, another had a ruptured kidney, and a third had a partial sixth nerve palsy, fractured humerus and fractured pelvis.

Nine (36%) had evidence of skull fracture. Two of this group had extradural haemorrhage which required surgical drainage and 4 had depressed skull fractures that were elevated.

Mechanism of head injury

The mechanisms of injury varied (Table 2). In all cases it was considered that the mechanism of injury was essentially a single acceleration–deceleration force.

Severity of injury

A Glasgow Coma Scale Score of 8 or less indicated a severe to critical injury.[18] On this basis, 5 (20%) of the head injuries were graded as severe to critical with a significant risk of death. Twenty (80%) were graded minor to serious. The ages of the 5 patients with severe to critical head injuries were 1.6, 2.7, 3.4, 7.7 and 11.3 years respectively. Four of the 5 children with Glasgow Coma Scores of <8 had closed head injuries. The fifth (and oldest) child had a minimally depressed fracture of the left temporal bone which did not require elevation.

The general severity of injury as graded by the Injury Severity Score (IIS) was severe (IIS$>$15) in 6 (24%) children, moderate (IIS$<$15 and $>$4) in 9 (36%) children and minor (IIS$<$4) in 10 (40%) children.

Ocular findings

No child had evidence of direct ocular trauma. There was no evidence of retinal haemorrhage in any of the children.

DISCUSSION

It is known that intra-ocular haemorrhage can result from very severe direct head injury. This haemorrhage may be secondary to subdural or subarachnoid haemorrhage.[19,20] In a recently reported study Alario *et al.* noted no retinal hemorrhages in a group of 50 children less than 2 years of age who had sustained mild to moderate head trauma.[21]

Table 2 Mechanism of injury

Mechanism	Number (%)
Fall*	8 (32)
Pedestrian struck by car	5 (20)
Bicycle/skate board accident**	5 (20)
Passenger motor car accident	3 (12)
Hit by missile†	3 (12)
Kicked by horse	1 (4)

*Distance of fall varied from 1 to 5 metres.

**Two bicycle riders were struck by a car, remainder fell from bicycle or skate board.

†Missiles include rock, shotput and another child's head.

The literature pertaining to the indirect ocular effects of head trauma is sparse. There is extensive literature relating to sudden visual loss following blunt head trauma,[22–24] however, with the exception of two cases of anterior ischaemic optic neuropathy,[25,26] the visual loss has been ascribed to optic nerve or chiasmal injury and not damage to the globe itself.

Raju, in a study of the ocular manifestations of head injury, describes no cases of retinal haemorrhage in the 40 patients examined.[27] Doden and Stark describe the fundus findings in 247 patients with sustained head injury and no direct eye trauma in an attempt to determine the role of head injury in the causation of retinal detachment.[28] Although these authors were not specifically looking for retinal haemorrhage, they examined 69 of their patients between 6 days and 6 weeks after injury and did not report finding retinal haemorrhages in any of these.

Retinal haemorrhages are a common finding in the shaken baby syndrome, while direct ocular injury is not a feature. The aetiology of the retinal haemorrhages in this special case of head injury is uncertain.[11] The following hypotheses have been advanced to explain the generation of these haemorrhages.

(1) Retinal haemorrhage is a manifestation of raised intracranial pressure secondary to subarachnoid or subdural haemorrhage or represents direct spread of the subarachnoid or subdural blood along the perineurium into the globe.[2,4,29]

(2) Haemorrhage results from increased central venous pressure caused by chest compression (a form of Purtscher's retinopathy) or by centripetal forces generated by swinging the child by a lower extremity.[29]

(3) Retinal haemorrhages result from intraretinal damage caused by the shearing forces created between the retina and overlying vitreous body when the infant's head is repeatedly and violently shaken.[5,9]

It is likely that all of these mechanisms may contribute to the generation of retinal haemorrhages in some instances.

Subarachnoid and subdural haemorrhage are common features of the shaken baby syndrome and, when severe, could well be the cause of some of the massive preretinal haemorrhages seen in abused children.[1,2,4] A case has been described in which the retinal haemorrhages were obvious but the intracranial component was minimal.[11] Thus, subarachnoid haemorrhage is unlikely to be the sole cause of retinal haemorrhage in the shaken baby syndrome.

The role of raised central venous pressure is not certain. Purtscher's retinopathy is a well recognized, though rare, sequel to chest compression. The chest compression required to cause retinal haemorrhages is usually severe.[30] Purtscher's retinopathy may be the cause of retinal haemorrhages in at least two cases of child abuse.[31] It is of interest that one of the children in this series had a chest injury sufficient to result in haemopneumothorax but there was no evidence of retinal haemorrhage.

It is not clear whether the force used to grasp a child by the chest while shaking it is sufficient to raise central venous pressure to the extent that retinal haemorrhages ensue. Force sufficient to cause rib fractures have been described in children subjected to shaking while grasped by the thorax.[32]

The possibility that cardiac compression as part of attempted resuscitation may cause retinal haemorrhage has been suggested.[6] One study suggests that cardiac compression alone does not cause retinal haemorrhage in children.[33] This study, however, was flawed by inadequate fundus examination and further study of this issue is required.[34]

The formation of retinal haemorrhages as the result of local intra-ocular injury caused by shaking is a more recent hypothesis.[9] These authors suggest the repeated back and forth whiplash movements of the head whilst shaken result in vitreous traction on the retina and subsequent splitting of the retina. Recently retinal folds have been described in babies subject to severe shaking and retinal slippage secondary to vitreous traction has been suggested to be the cause of this.[35]

In the more severe cases of the shaken baby syndrome, there is frequently evidence of skull fracture suggesting blunt trauma to the head in addition to shaking.[36] The role of this blunt trauma in the generation of retinal haemorrhages is unclear. The results of the current study suggest strongly that blunt trauma alone to the child's head does not result in retinal haemorrhage.

In cases of suspected child abuse with retinal haemorrhage and a history of head trauma, or signs of head injury, the aetiology of the retinal haemorrhages is uncertain. It may be difficult to state categorically that the purported head injury was not the cause of the retinal haemorrhages. Medico-legally this is a matter of some importance as these cases often come before the courts and opinion regarding the cause of the haemorrhage sought.

In this study of 25 children who sustained accidental head injuries with varying degrees of severity, no evidence of retinal haemorrhage was found. This finding supports the clinical suspicion that true accidental head injury is rarely associated with retinal haemorrhage and is in agreement with the recent report of Alario *et al.*[21]

The lack of retinal haemorrhages in accidental head injury is most likely a reflection of the mechanism of injury. In accidental head injury the head generally undergoes one or two rapid deceleration forces as it strikes some relatively immobile object such as the ground or the inside of a car. While in the majority of cases of the shaken baby syndrome there are almost certainly repeated rapid acceleration–deceleration forces applied to the head. In the most severe cases of the shaken baby syndrome blunt deceleration forces may be an important contributing factor to the parenchymal brain injury sustained.[36] In lesser degrees of shaking injury, however, evidence in the form of skull fractures or scalp contusions is generally lacking.

When applying the findings of this study to the shaken baby syndrome caution must be exercised, as less than half of the children studied were in the age typically associated with the shaken baby syndrome. It seems reasonable, however, to conclude that the finding of retinal haemorrhage in any child purported to have sustained accidental injury should raise suspicion of abuse. Similarly it also makes the assertion that an accidental injury as the cause of retinal haemorrhages less tenable.

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