

Retinal Hemorrhages and Apparent Life-Threatening Events

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Objective: To determine the prevalence of retinal hemorrhages in apparent life-threatening events (ALTEs) with the purpose of facilitating the differential diagnosis of the cases of nonaccidental head trauma.

Methods: Prospective study on children aged 15 days to 2 years admitted to our hospital with a diagnosis of an ALTE over a period of 2 years (May 2004–May 2006). All the children underwent detailed ophthalmologic examination within 72 hours of admission. If retinal hemorrhages were detected, further investigation was undertaken to rule out systemic disorder or maltreatment.

Results: One hundred eight children with an ALTE were examined. No patient was found to have retinal hemorrhages nor was any found to have experienced child abuse. Therefore, using the Hanley rule of 3, we can be confident to an upper limit of 95% that the chance of retinal hemorrhages occurring as a result of an ALTE alone is at the most 0.028.

Conclusions: Apparent life-threatening events alone are unlikely to cause retinal hemorrhages in children younger than 2 years. Therefore, if retinal hemorrhages are detected, investigation into the possibility of nonaccidental injury is essential.

Key Words: retinal hemorrhages, maltreatment, nonaccidental head trauma, apparent life-threatening event

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Apparent life-threatening events (ALTEs), as defined by the 1986 National Institutes of Health Consensus Panel on Infantile Apnea, are events that are characterized by some combination of apnea, color change, marked change in muscle tone, choking, or gagging and are frightening to the observer.¹ Apparent life-threatening events are the presentation form of multiple pathologies, and nonaccidental head trauma is one of them.^{2–5} The shaken baby syndrome (SBS), currently defined as part of a more comprehensive diagnosis of abusive head trauma (AHT), is an extremely serious form of AHT that occurs when a child is subjected to rapid acceleration, deceleration, and rotational forces, with or without impact, resulting in a unique constellation of intracranial, intraocular, and cervical spinal cord injuries.^{6–10} An ALTE is the chief complaint in 21% of nonaccidental head trauma cases.⁹ However, diagnosing nonaccidental head trauma in a child who presents with an ALTE may be difficult, as readily apparent signs of trauma may not be visible. Retinal hemorrhages are one of the most characteristic nonaccidental head trauma findings. The most common sites of retinal hemorrhage in this group is near the ora serrata and, the second one, in the posterior portion of the eye, near the disc and the macula. The hemorrhages of AHT are usually intraretinal and bilateral and may show different ages and stages of hemorrhage and reabsorption in different areas of the retina.^{10,11} The documentation of their presence

in children who present with an ALTE may help to identify children who have been abused. Nevertheless, in theory, an ALTE and other causes may potentially cause retinal hemorrhages as a result of a sudden rise in retinal venous pressure after a rise in central venous pressure secondary to an increase in intrathoracic pressure.^{12–14} Therefore, the prevalence of retinal hemorrhages after an ALTE remains unclear. Studies have concluded that the chances of developing hemorrhage after an ALTE are low,^{15,16} but those studies are not enough to determine the prevalence with certainty. Therefore, the objective of this prospective study was to determine the prevalence of retinal hemorrhages in ALTEs with the purpose of facilitating the differential diagnosis of nonaccidental head trauma cases.

METHODS

Study Site

The setting for the study was the Sant Joan de Déu Hospital, a 275-bed tertiary care pediatric hospital located close to Barcelona. The emergency department sees approximately 109,500 children annually and receives most pediatric emergency cases for a metropolitan area of 1,200,000 people.

Patients

Children aged 15 days to 2 years admitted to our hospital with signs and symptoms consistent with the National Institutes of Health's definition of an ALTE¹ were studied prospectively over a period of 2 years (2004–2006). Children with a history of trauma, suspected child abuse, or other recognized causes of retinal hemorrhages were excluded.^{3,12,17}

All the children underwent detailed ophthalmologic examination within 72 hours of admission. The fundoscopic examination was carried out by an expert ophthalmologist using indirect ophthalmoscopy. The pupils were dilated with short-acting mydriatic agents. For children with positive findings (retinal hemorrhages), an in-depth investigation was carried out to rule out maltreatment. The study included at least 1 head computed tomography and/or magnetic resonance imaging to exclude subdural and/or subarachnoid hemorrhages, a skeletal survey and/or bone scintigraphy to exclude fractures, and a full blood count and coagulation study to exclude blood dyscrasias. Those patients suspected of having sustained child abuse were evaluated by a multidisciplinary team composed of pediatricians, psychologists, neurosurgeons, ophthalmologists, and social workers. Their conclusions were referred to the government's management agency for children and adolescents.

Data Collection

A physician data manager visited the pediatric regular unit and the 14-bed pediatric intensive care unit on a daily basis to examine the histories and admitting diagnoses in the medical charts of all newly admitted infants to identify study subjects. Patients meeting the inclusion criteria were enrolled in the study after informed consent to undergo ophthalmologic examination was obtained from their parents and the supervising medical

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team. The extent and the direction of other evaluations depended on the initial assessment and the clinician's clinical judgment. The patients were followed up until hospital discharge.

Statistical Study

Data analysis was conducted using SPSS 12.0 software (Chicago, Ill). The study population was described using frequencies and percentages for categorical variables and using means and SDs or medians and ranges for continuous variables. As we presumed that an ALTE retinal hemorrhage is rare, we used the binomial test to estimate the statistical probability of such an event. If none of the *n* patients showed retinal hemorrhages, statistical analysis was undertaken using the Hanley rule of 3; we can be 95% confident that the chance of this event is at most 3 in *n* (that is, 3/*n*).^{18–20}

RESULTS

From May 1, 2004, to April 30, 2006, 108 patients were admitted to our hospital with an ALTE, as defined by the National Institutes of Health.¹

TABLE 1. Characteristics of the Study Population (*n* = 108)

Demographic data	
Age, median (range), mo	1.5 (0.5–13.8)
Sex, male-female	65:43
Antecedents	
Family history of ALTEs	4 (3.7)
Family history of SIDS	6 (5.5)
Smokers in home	33 (30.3)
Clinical characteristics	
Time from last feeding, median (range), min	30 (0–240)
Occurred during sleep	31 (28.7)
Position during sleep	
Prone	3 (9.7)
Supine	8 (25.8)
Unknown	20 (64.5)
Occurred during cough	18 (16.7)
Occurred during crying	7 (6.5)
Color change	92 (85.2)
Plethora	31 (33.7)
Pallor	14 (15.2)
Cyanosis	47 (51.1)
Change in muscle tone	61 (56.5)
Hypertonia	23 (37.7)
Hypotonia	38 (62.3)
Clonic movements	3 (2.8)
Altered mental status	28 (25.9)
Duration	
Shorter than 30 s	65 (60.2)
30 s to 1 min	18 (16.6)
1–5 min	25 (24.0)
Recuperation	
Spontaneous	21 (19.4)
Stimulated	80 (74.1)
CPR performed	7 (6.5)
Multiple ALTEs within 24 h	49 (45.4)

The data are reported in *n* (%) unless indicated otherwise.

CPR indicates cardiopulmonary resuscitation; SIDS, sudden infant death syndrome.

TABLE 2. Yield of Diagnostic Tests in the 108 Patients

	Positive Findings, <i>n</i>	Tests Performed, <i>n</i>
Blood		
Blood test	1	52
Electrolyte balance	1	52
Metabolic screen	0	31
Cerebrospinal fluid	0	4
Nasopharyngeal aspirate		
RSV antigen	9	65
Influenza antigen	0	30
Pertussis PCR	0	28
Imaging		
Chest radiograph	5	49
Upper gastrointestinal series	8	31
Echocardiogram	7	37
Cranial ultrasound	0	36
Monitoring		
Electroencephalogram	0	24
Pneumocardiogram	22	87
Electrocardiogram	0	26
pH probe	5	9
Polysomnography	3	16
Fundoscopic examination	0	108

The definition of a positive laboratory test was based on age-specific ranges for normal from *The Harriet Lane Handbook, 16th Edition*.²² An imaging or monitoring study was considered positive on the basis of the interpretation of the responsible subspecialist.

PCR indicates polymerase chain reaction; RSV antigen, respiratory syncytial virus antigen test.

Table 1 presents the demographics, antecedents, and clinical characteristics of the study patients.

Table 2 shows the number of tests performed and the number of positive test results, and Table 3 shows the patients discharge diagnoses. These diagnoses were suggested by positive findings from the initial history and/or physical examination in 59.2% (64 of 108) of the study patients. Among all the tests performed, the pneumocardiogram was the one that most often contributed to an ALTE diagnosis. Twenty-four-hour continuous pneumocardiogram recordings were obtained on 87 patients; 22 demonstrated apneic episodes longer than 20 seconds in duration and/or a bradycardia of less than 70 beats per minute. Twenty of these 22 patients were found to have central apnea; and 2, bronchiolitis. Six of the 7 positive echocardiograms were abnormalities (eg, patent foramen oval) that were not linked to the cause of the ALTE.

No patient was found to have retinal hemorrhages nor was any found to have experienced child abuse. Therefore, using the Hanley rule of 3, we can be confident to an upper limit of 95% that the chance of retinal hemorrhages occurring as a result of an ALTE alone is at the most 0.028.

DISCUSSION

Infants with an ALTE often pose a diagnostic and management dilemma in pediatric emergency departments. Although most episodes, as we have seen, are associated with easily identifiable causes, there are others more difficult to diagnose.²¹ The aim of this study was to ascertain whether an ALTE alone can

TABLE 3. Discharge Diagnoses in 108 Patients

Diagnosis	No. Patients, n (%)
Gastroesophageal reflux	45 (41.6)
Central apnea	20 (18.5)
Bronchiolitis	12 (11.1)
Unknown cause	11 (10.2)
Airway obstruction in upper respiratory tract infection	11 (10.2)
Breath-holding spells	7 (6.5)
Vasovagal response	1 (0.9)
Interventricular communication decompensated	1 (0.9)

When more than 1 discharge diagnosis was listed in a patient's medical record, the diagnosis most likely to have caused the ALTE is reported.

produce retinal hemorrhages to see if this test could be useful for the identification of nonaccidental head trauma with appearance of an ALTE. Forty-one percent of the cases studied were ALTEs longer than 30 seconds and 45% were multiple ALTEs. Although these circumstances would theoretically be enough to increase retinal venous pressure as a result of a sudden rise of the intrathoracic and central venous pressures and produce retinal hemorrhages,^{12–14} no retinal hemorrhages were detected. Therefore, in our study, none of the 108 children younger than 2 years were found to have retinal hemorrhages within the 72 hours of their admission after an ALTE. These results show that only on rare occasions (prevalence lower than 0.03) is an ALTE associated with retinal hemorrhages.

Previously, Pitetti et al,¹⁶ in a prospective study in which one of the objectives was to determine the prevalence of retinal hemorrhages in ALTEs, performed dilated fundoscopic examination on 57% (73 of 108) of patients and detected 1 with retinal hemorrhages. This patient, together with another 2 patients without retinal hemorrhages, was found to have experienced child abuse. Altman et al,¹⁵ in a review of ophthalmologic findings from a series of 120 (49.4%) children who underwent an ophthalmologic examination of 243 with an ALTE, also detected 4 retinal hemorrhages, with their final diagnosis being SBS. Another 2 of the 120 patients were also found to have SBS. In summary, by combining the results of our present study with those from these 2 prior studies, we could not observe any case of retinal hemorrhage in the 292 reported nonabused patients. Therefore, using the Hanley rule of 3, the upper limit of 95% confidence interval of retinal hemorrhages after ALTEs in children younger than 2 years is less than 0.01. This small prevalence is much lower than that observed in maltreated children (0.76 in the study of King et al⁹).

In conclusion, ALTEs alone are unlikely to cause retinal hemorrhages in children younger than 2 years. Therefore, if retinal hemorrhages are detected, investigation into the possibility of nonaccidental injury is essential to safeguard the patient and the siblings.

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