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Clinical practice

The optic nerve sheath hemorrhage is a non-specific finding in cases of suspected child abuse

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ABSTRACT

In young infants, the triad consisting of acute encephalopathy, retinal hemorrhages, and a subdural hematoma is a nonspecific finding. It has traumatic and non-traumatic etiologies. The triad may be found among a vast spectrum of natural diseases. Optic nerve sheath hemorrhage in infants is typically detected at autopsy. It is a nonspecific finding that can be found in traumatic and non-traumatic etiologies. Neither the triad nor the ONSH are pathognomonic for an abusive head injury. Opposite to the triad, the spectrum of non-traumatic etiologies of ONSH is limited. In infants ONSH rarely occurs in spontaneous subarachnoidal hemorrhage or in infectious conditions. Our results show that the clinical significance of the optic nerve sheath hemorrhage in the forensic work-up of fatal cases of alleged abusive head injury is its limited differential diagnosis. Only after careful differential diagnosis ONSH may contribute to the diagnosis of AHT. However, the main limitation of our study is the sampling bias, as the eyes are usually removed when abusive head trauma is suspected.

1. Introduction

For decades the classic triad or the combination of subdural hematoma (SDH), acute brain damage, and retinal hemorrhages (RH), formed the basis of the shaken baby syndrome (SBS). However, attributing these brain and ocular injuries to shaking was questioned[1] following experiments concluding that manual shaking could not cause the triad injuries. Without at least head impact.[2–6] The issue remains a hotly debated area in forensic medicine[5,7–18]. Recent experiments on lambs proved that shaking alone can result in fatal brain damage.[19] However, none of the shaken lambs show any evidence of bleeding in the retina, the optic nerve or the uvea (iris, ciliary body and choroid). The less mechanistic term abusive head trauma (AHT) preferably is used.[20]

The triad of injuries has traumatic and non-traumatic etiologies. The spectrum of non-traumatic etiologies is vast for each of the three components and can be found in infectious, metabolic, and genetic diseases, as well as in coagulation disorders.

Optic nerve sheath hemorrhage (ONSH) is detected only during postmortem examination. An ONSH has been visualized on a CT scan performed on a 53-year-old male with Terson Syndrome (TS), a severe spontaneous subarachnoidal hemorrhage (SAH) associated with a vitreous bleeding and an ONSH.[21]

ONSH is a non-specific finding that can be caused by traumatic and non-traumatic etiologies. It may occur after fatal head injuries, in crashes such as motor vehicle accidents (MVA), and in unusual scenarios, such as when a television set topples over, and in one case of a stairway fall.[22–28]

It is extremely rare to find ONSH and RH accompanying TS in infants,[29–34]. The occurrence of ONSH in an infant with TS has been described in only three infant cases.[35–37]

RH may accompany infectious diseases 38, but little is known about the incidence of ONSH in conjunction with infectious conditions. Only one case of meningitis with sepsis (Group A Streptococcus), RH, and ONSH, with the infectious process extending into the optic nerve sheaths, has been reported.[39] In this case, the retina was not involved in the infectious process.

ONSH has been linked to an abrupt rise in intracranial pressure (ICP)[40] only in adults – not in infants or in pathologies other than SAH.[32] Papilledema is a hallmark of increased ICP, and small nerve-fiber layer hemorrhages commonly occur with dilation of the optic nerve sheath.[34] No other support could be found in the literature.

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This paper aims to report the detailed analysis of five judicial files, in order to assess the clinical significance of ONSH in the presence of the triad, in the work up of cases of alleged abusive head trauma.

2. Forensic material and methods

The five cases of ONSH originated from 48 judicial cases under criminal investigation by various courts in the jurisdiction of the Courts of Appeals of Antwerp and Ghent. Approval to study these judicial cases, whether ongoing or after judicial ruling, was given by the Attorney General of Antwerp and Ghent. Because the Attorney General approved the disclosure of cases for scientific research that were from time to time still under "secrecy of the judicial investigation," approval of an ethical committee was not sought. To safeguard the "secrecy of the judicial investigation," the authors presented the cases anonymously to the best possible extent.

The authors had access to details from the criminal files, including police interrogations of suspects, and to the medico-legal reports (forensic autopsy, forensic investigation, forensic medical examination, and seized medical files). In the analysis, 145 parameters were searched for, divided into 16 groups. ONSH was included in a second analysis for the purpose of this study.

38 of the 48 files were deemed appropriate to undertake the analysis. The files were provided as they were collected in the archives of the courts under the heading of child maltreatment without further specifications. The stories or confession of the caregivers had to admit as described in the files and has to be seen as quotes not as facts and without the possibilities to change or verify them.

From the 38 complete files 21 were files of death infants. Autopsies were performed in 17 out of these 21 death cases. RH was found in nine cases and both RH and ONSH were found in five cases. In one of these five cases (Case 1) only the right optic nerve (ON) was examined and an ONSH was found. In another case, the ON also was examined in only one eye but no ONSH was found. The autopsy reports in 11 cases did not note an (ON) examination. Images were not available in the court archives so that illustrations cannot be added to the text.

3. Results

3.1. Description of five forensic cases

3.1.1. Case 1

A 25-month-old infant was hospitalized after convulsions evolving quickly into a deep comatose condition. He then was sedated and intubated, and quickly transferred to the University hospital. There were with ecchymoses all over the body and face at the right side, a torn frenulum of the upper lip, and scleral bleeding in the left eye. A CT scan showed a bilateral temporal subgaleal hematoma (SGH), no visible skull fracture, and a right frontal SDH with mass effect. Diffuse cerebral edema with a white cerebellar signs. Subarachnoidal blood was found over the tentorium. A funduscopy showed several superficial intraretinal hemorrhages, 5 right, 1 left side, a normal posterior pole and retinal periphery. Two and a half hours after the CT scan, the neurosurgeon urgently evacuated the massive acute SDH. The infant died 6 days later. The parents' initial stories were inconsistent. Later they confessed to have brutally maltreated the infant nearly continuing, but they denied ever to have shaken the infant.

The autopsy also showed residual subdural bleeding and a swollen brain with tonsillar and uncal herniation and contusional hemorrhages. Only the right eye with optic nerve was removed and examined. Resorbing retinal bleedings and perineural hemorrhages around the optic nerve were found. Reconstruction of the time sequences indicated that a lucid interval (LI) of 8 h occurred from the occurrence of the ultimate violent act at noon until 8 p.m., before the convulsions started and the infant collapsed. The father was sentenced to prison because of cruel treatment, and not for shaken-impact AHT.

3.1.2. Case 2

Emergency personnel were called when **a nine-week-old** male infant with no previous health problems suddenly collapsed. Upon arrival, they found an unresponsive infant who was cyanotic, had no spontaneous respiration (apnea) and had maximally dilated pupils. Despite resuscitation and intensive care treatment, the infant died two days later. CT and MR showed a thin-film type of SDH over both parietal areas, with an interhemispheric extension and brain edema. The radiologists interpreted the different blood components in the collections as indicating different dates of trauma or re-bleeds. A bilateral intraretinal RH was found with retinal detachment and vitreous extension. Laboratory tests showed low initial hemoglobin of 4.9, low hematocrit of 16.4, a low red blood cell count of 1.75, and a platelet count of 423,000. No clot formation was observed. Seven hours after administration of blood and fresh frozen plasma, the laboratory values and the coagulation tests normalized, with an INR (International Normalized Ratio) of 1.58. The infant died 30 h after admission. The postmortem examination showed a small focal impact point with an underlying galea bleeding of 2×1 cm and a smaller one at the left frontal and temporal side. There were some small scalp bleedings at the left parietal side and, but there was no skull fracture. Deep intramuscular bleeding was found over the right scapula. Two recent small ecchymoses were found centrally located at the back of the infant, along with two small abrasions at the neck and additional reanimation injuries at the ventral and dorsal thorax. A perineurial ONSH was shown macroscopically and microscopically. Deposits of iron, together with fresh red blood cells, were seen as an indication of recent and less recent bleedings at the leptomeninges. Postmortem re-examination of the blood samples taken during life showed prolonged prothrombin time (PT) and activated partial thromboplastin time (aPTT). Because of inadequate preservation of the blood samples, postmortem coagulation tests were considered inconclusive. The infant had not experienced any previous health problems. More particularly there were no signs of easy bleeding, and no hereditary health problems were reported. The parents, who were with the infant prior to the collapse, had no explanation for what had happened.

The infant had not experienced any previous health problems, particularly signs of easy bleeding, and no hereditary health problems were reported. Social workers' and judicial investigations revealed no reason to suspect the parents. An accidental head trauma was considered more probable than an AHT. No prosecution was pursued.

3.1.3. Case 3

The biological father of a 28-week-old female infant brought the child to a nanny at 5 a.m. in good health and with no previous problems. Three and a half hours later, the infant woke up, cried, and drank half a bottle of milk. She then collapsed suddenly, became limp, and fell into a deep coma. The nanny and then the general practitioner attempted resuscitation. The infant was brought to the emergency department and died two days after admission. Imaging showed a parieto-occipital right SDH with interhemispheric and tentorial extension, with an overlying skull fracture extending over the lambdoid suture and subgaleal hematoma over the area of the skull fracture. Bleeding points were seen in the left parietal area. The postmortem examination also showed