



## Non-accidental injury of vision organ in children

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### ABSTRACT

Non-accidental injuries (intentionally inflicted) arise as a result of physical harm, they represent 5% of all injuries of the vision organ and often coexist with other symptoms of child abuse (battered child syndrome). Most often, the age of the physical abuse of children does not exceed 3, although it may affect children at any period of life. Non-accidental injuries related with the vision organ directly affect the eyeball and orbit or may result in head injury. Especially serious visual complications arise in infants, due to damage of the retina and optic nerve in the shaken baby syn-

drome. Symptoms of the child abuse also include Münchhausen syndrome by proxy, in which the caregivers of the child report symptoms of non-existent diseases on his behalf and demand their treatment. Non-accidental injuries of the vision organ require differentiation between accidental injuries and pediatric diseases with similar symptomatology.

**KEY WORDS:** child abuse, shaken baby syndrome, ocular injury, Münchhausen syndrome by proxy.

The terms “child abuse” and “battered child syndrome” have existed in the medical literature for over 50 years. The American pediatrician Henry Kempe was the first to introduce the term “battered child syndrome” into clinical practice in 1962 [1]. Currently, other names are also used to refer to child maltreatment including Silverman syndrome, Cafey-Kempe syndrome, Tardieu syndrome, abused child, non-accidental injuries, and parent-infant traumatic stress syndrome [2]. There is not a single continent or country where physical violence against minors does not occur, regardless of the race, economic status or education of the population [3-5]. Globally, approximately 40 million children under the age of 14 are victims of abuse and neglect; in highly developed countries, the proportion of abused children reaches 4-6% [6, 7]. In Poland, the main official sources of data on the scale of the problem of violence against children are court and police statistics. According to the Polish Ministry of Justice, from three to over four thousand children and adolescents under 18 years of age fall victim to physical and other types of criminal abuse every year [8]. Based on the report on the implementation of the “Blue Cards” police procedure for handling domestic violence, which only includes forms filled out by police officers, a total of 12,404 minors were victims of violence in 2018, and 12,181 in 2019. The figures exclude data collected by

other (non-police) entities authorized to combat domestic violence.

Since the first reports of child abuse, the pool of knowledge about this not only medical problem has greatly expanded. Based on the current WHO definition, as summarized by Horst-Sikorska *et al.*, battered child syndrome refers to “any intentional or unintentional action by an adult, community or state resulting in harm to the child’s health, and physical and psychosocial development” [9]. Child abuse may take a variety of forms, the most common of which are: neglect (54%), physical ill-treatment (22%), sexual abuse (8%), and emotional ill-treatment (4%). Other types of child abuse are less prevalent (12%) [10-11]. Various risk factors have been found to contribute to the battered child syndrome. Most of them are related to the parents/caregivers. They may be associated with the children themselves, and changes to their identity (physical and mental status, developmental defects, disability, premature birth, CNS disorders, delayed psychophysical development). Environmental factors have also been shown to have a degree of negative impact. Originally, the concept of battered child syndrome referred to the youngest children who were intentionally injured physically. However, the extensive scale of the phenomenon has eliminated the age restrictions. Most commonly (in approximately 60% of cases), the age of physically abused children is less than three

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years. Young children constitute a third of all children hospitalized for maltreatment-related injuries, and infants under the age of one account for half of the group. Regardless of the child's age, battered child syndrome and physical abuse are characterized by the presence of non-accidental bodily injuries which, occasionally, may be difficult to differentiate from accidentally sustained injuries [1-2, 8, 12-14]. The syndrome is a common cause of permanent bodily harm and even death of physically abused children. Non-accidental injuries may involve any single organ, including the ocular system, or multiple organs. Injuries resulting from physical maltreatment account for 5% of all eye injuries and often coexist with other manifestations of the battered child syndrome. Physical abuse may cause direct (primary) injuries involving only the victim's eyes (isolated injury type). In other cases, ocular lesions may be an indirect (secondary) effect of non-accidental head injury. The latter type is more commonly encountered. Injuries sustained as a result of physical abuse may affect individual elements of the ocular system or the entire organ of vision [15, 16], which is reflected in the clinical presentation. Orbital bone fractures commonly arise in association with craniofacial injury. A blow with a hand or a tool may cause edema, periorbital hematoma, and hemorrhages involving the eyelids and conjunctiva, and the anterior chamber. Hyphema identified in the anterior chamber – in the absence of an apparent etiological cause – should always raise suspicions of a non-accidental injury. Injury can induce changes in the deeper structures of the eye, in the lens, the vitreous body, the retina, and the optic nerve. An injury to the lens may cause its dislocation (subluxation or luxation), often accompanied by lenticular opacities. Post-traumatic intravitreal hemorrhage may be isolated or associated with retinal tear or detachment, and intraretinal hemorrhaging. An injury intentionally inflicted on the child may result in damage to the optic nerve. Based on our own observations, in particularly drastic cases, the nerves may be torn out of the eyeball. Another form of physical abuse of children is deliberate burning of normally exposed body surfaces, including the eyelids and corneas. Usually, they are thermal burns, inflicted with a lit cigarette. Most injuries occurring with purposeful intent are contusions and closed injuries, though a blunt impact to the eye area may sometimes lead to a ruptured globe.

A distinctive type of non-accidental ocular injuries involves retinal lesions arising secondary to head injury. Such cases may present diagnostic difficulties in differentiating the resulting abnormalities from accidental head injury [17-20]. Hemorrhagic retinal lesions, which are the most prevalent ocular manifestation of head injuries, occur in 85%-100% of cases; less commonly, hemorrhagic lesions in the retina are unilateral (10%-15%). Hemorrhages, especially in infants under one year of age, are usually bilateral, extensive and multilayered (preretinal, intraretinal and subretinal). The most common site of retinal hemorrhage is the ora serrata (40%), followed by the optic disc and the macula (20%), from where hemorrhaging spreads to the circumference of the retina [21].

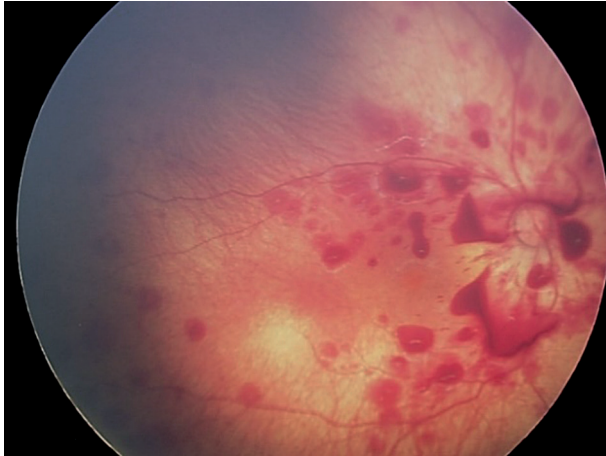
Hemorrhages can arise from injuries directly damaging the vessel wall, the presence of post-traumatic vitreoretinal tractions, elevated intracranial pressure, increased central venous pressure, and hypoxia. The effects of retinal injury may lead to permanent impairment of visual acuity or even loss of vision.

The youngest children are particularly exposed to ocular damage occurring as a result of the shaken baby syndrome (SBS) [22-23]. This type of non-accidental injury associated with shaking an infant was first described by the British neurosurgeon Norman Guthkelch in 1971 [24]. The syndrome is observed in children under five years of age, predominantly infants less than six months of life, and represents the most common cause of death (30%) or severe neurological damage (70%). It is specific to the period of infancy and associated with its unique anatomical characteristics [25]. Violent shaking and grabbing an infant by the limbs and chest – occasionally combined with impacting the head against a hard surface – causes injury to the affected areas, but also harms the head and eyes due to the effect of forces typically involved in acceleration-deceleration injury. During forceful shaking (jerking, tossing), the baby's head swings back and forth inertly due to weak neck muscles. Consequently, the brain is damaged after being repeatedly thrown against the inside of the hard bony skull. First, the meningeal blood vessels are ruptured, causing hemorrhages, and then submeningeal (subdural and subarachnoid) hematomas are formed. Cerebral edema develops, with accompanying features of ischemia and hypoxia of the nervous tissue, subsequently leading to cerebral softening (encephalomalacia). The triad of symptoms associated with SBS is completed by retinal hemorrhages, most of them occurring in both eyes. The fundus of the eye reveals signs of retinal concussion, hemorrhagic changes, blood effusions and petechiae in various stages of evolution: fresh hemorrhages and post-hemorrhagic foci, retinal detachment, papilledema or features of neural atrophy. The figures below, from our own collection, show ocular lesions secondary to the shaken baby syndrome.

Various stages in the evolution of lesions at the fundus indicate the repetitive nature of injuries (i.e. long-term physical abuse of the infant).

If suspicions of SBS are raised, ophthalmologists performing the eye examination in the child have a particularly important role to play, with ophthalmoscopic assessment being especially relevant for the evaluation of suspected child abuse. Ophthalmic examination should preferably take place within the first 24 hours of injury, as small or superficial hemorrhages often resolve quickly, which hinders further diagnostic management. Lesions at the fundus are uncommon in accidental head trauma in children.

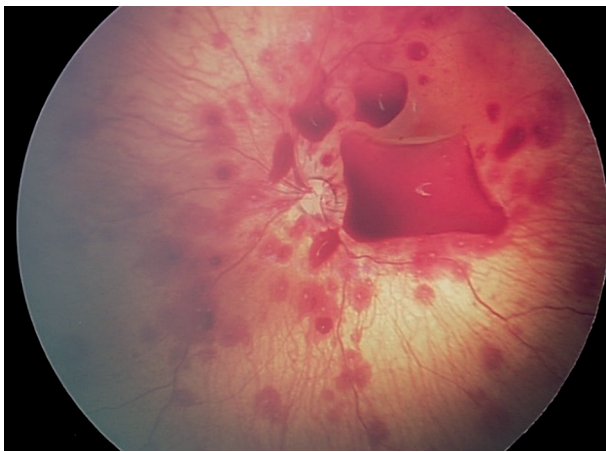
The diagnosis of non-accidental ocular injury, similarly to any other manifestation of the battered child syndrome, requires thorough history taking and detailed physical examination, and often multiple additional specialist laboratory tests and consultations. An important diagnostic factor is the child's age, and injuries identified in infants and young



**Figure 1A.** Fundus of right eye in SBS in a 6-month-old girl – a preliminary examination. Multiple pre- and intraretinal hemorrhages, different largeness and intensity



**Figure 1B.** Fundus of right eye – a month later. Single, absorbent hemorrhages in the peri-disc region, pale disc of the optic nerve



**Figure 2A.** Fundus of left eye in the same girl – a preliminary examination. Numerous pre- and intraretinal hemorrhages with the extensive pre-macularis hemorrhage. Swelling of the retina



**Figure 2B.** Fundus of left eye – a month later. Absorbent pre-macularis hemorrhage and the vitreous haemorrhage

children always require careful history taking and ascertaining the circumstances in which they arose. A medical history collected from the child's parents/caregivers should always raise the suspicion of physical abuse if it is frequently changed or inconsistent with the clinical findings. An essential part of the diagnostic process is physical examination performed to determine the child's general and neurological condition, combined with a detailed ophthalmic evaluation. Among additional examinations, an important diagnostic and differentiating value is attributed to skeletal radiology, computed tomography, and magnetic resonance imaging. Already several decades ago, John Cafey, an American pediatrician and radiologist, drew attention to the occurrence of long bone fractures and subdural hemorrhages in some hospitalized children, aptly noting that infants are unable to break their limbs by themselves, and such injuries are a consequence of physical harm intentionally inflicted on them: "the bones tell a story that a young child cannot and the parents do not want to tell" [26]. During the differential di-

agnostic process, it is necessary to rule out genetic metabolic diseases (Marfan syndrome, homocystinuria); systemic infections and neuroinfections caused by various pathogens, with hemorrhagic lesions in the fundus which are usually isolated (no more than five hemorrhagic foci) [21]; intraocular infections (TORCH, syphilis) with intravitreal and intraretinal hemorrhages or with features of acute ischemic retinal necrosis; and retinopathy of prematurity. Also, the presence of coagulation disorders must be eliminated in the process of arriving at the diagnosis. Additionally, as part of the differential procedure physicians consider eye fundus changes due to intracranial developmental vascular malformations, accidental head injuries, and Purtscher retinopathy.

An evaluation of non-accidental eye injuries in children should take into account the possibility of Munchausen syndrome and Munchausen syndrome by proxy (MSBP) [27-29]. Both conditions can be described as mental disorders in which either patients themselves or other persons report a variety of dramatic health symptoms. In the ICD-10

International Statistical Classification of Diseases and Related Health Problems, Munchausen syndrome is defined as “intentional production or feigning of symptoms or disabilities, either physical or psychological [factitious disorder]”. Patients with Munchausen syndrome intentionally induce and fabricate physical symptoms of illness. A few years ago, a report appeared in the ophthalmic literature, describing the case of a young girl with hemolacria (bloody tears) [30]. The 16-year-old patient reported bleeding from both eyes. However, a thorough eye examination revealed no abnormalities. The results of laboratory tests were normal as well. The “bloody tears” turned out to be blood smeared by the patient on the cheeks after pricking her fingertips with a hair clip, when she was left unattended. In their clinical practice, the authors of this paper encountered a similar case of a teenage girl who, taking advantage of momentary inattention on the part of medical staff, rubbed the eye area with blood from fingers pricked with a pin (which she kept in her pocket) to feign bloody tears. Munchausen syndrome by proxy is a condition which has its roots in a child’s caregiver being pathologically overprotective. Consequently, the caregiver (usually the mother) reports various complaints and imaginary symptoms of non-existent diseases on behalf of the child. Importantly, the symptoms are always manifested in the absence of medical personnel [27]. The disorder is encountered by physicians

of various pediatric specialties. In pediatric ophthalmology, the reported symptoms are most commonly a result of intentional administration of irritants to the conjunctival sac, causing reddening of the eyes, lacrimation, and impaired vision. Mothers with Munchausen syndrome by proxy demand a diagnosis and treatment of fabricated illnesses in their children.

In addition to the medical side, non-accidental injuries in children also have a legal aspect. In accordance with the Polish law, pursuant to Art. 304(1) of the Code of Criminal Procedure, every physician examining a child suspected of having sustained a non-accidental injury is obliged to report the incident to the police (prosecutor’s office).

In conclusion, an ophthalmologist identifying ocular lesions for which there is no reasonable explanation in a child should include battered child syndrome in the diagnostic work-up. On the other hand, any child suspected of sustaining a non-accidental injury by physicians of other specialties requires an ophthalmic examination. Ocular changes are very important in the diagnostic process when SBS is suspected, being an integral component of the syndrome. An ophthalmic examination can be critical to the diagnosis and appropriate treatment of abused children.

## DISCLOSURE

The authors declare no conflict of interest.

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