Unusual eye injury related to abusive head trauma

Introduction

An immediate ophthalmological examination is an indispensable element in medical evaluation of suspected abusive head trauma (AHT) in children under 2 years old [1] or 5 years old [2, 3]. The main ophthalmological finding after child AHT is retinal hemorrhaging, which occurs in 50–100% of cases [4–9], whereby retinal hemorrhage severity is proportional to the severity of the neurological injury [10, 11]. Retinal hemorrhages mostly occur in both eyes [9]. Patterns of retinal hemorrhages are diagnostically important, but they can be barely visible when preretinal or vitreous hemorrhages are simultaneously present [12]. Scientific consensus on the etiology of retinal hemorrhages in AHT is that repetitive acceleration-deceleration forces lead to vitreoretinal traction [4].

The damage caused by retinal hemorrhaging depends on how much the fovea is involved and is generally not the reason for blindness itself [13]. Nevertheless, visual impairment and blindness are present in long-term survivors of AHT [4], mostly caused by vitreous hemorrhage, retinal scarring or fibrosis [13].

Case report

Initial clinical findings

The 3-month-old infant was admitted to the emergency department by the rescue service due to a first afebrile seizure and breathing pauses. The parents reported fiddling (German: *fäusteln*), mouth movements and twisting of the eyes occurring out of sleep. Afterwards, the

infant was no longer able to adequately react.

In the clinical admission report, the infant showed reduced general and proper nutritional condition. Fontanel tension was slightly above normal. The infant was hyperexcitable and showed shrill screaming and intermittent apathy with low spontaneous motor activity. Muscle tone was normal to increased. The skin colour was pale. Further clinical examination showed no abnormalities.

Due to suspected acute cerebral pressure, a brain computed tomography (CT) (■ Fig. 1) was performed, which showed bilateral chronic subdural hematoma and a fresh parafalxine-accentuated subdural hematoma with a maximum width of 0.9 cm and different density values. Bilaterally a reduced delineable furrow relief was also found.

The ophthalmological findings on the day of admission showed a sluggish pupil reaction. There was a hesitant light reaction. The anterior segment of both eyes showed no irritation, with clearly refractive media. Ophthalmoscopy revealed massive subhyaloidal hemorrhages at the posterior pole and extensive flame-shaped intraretinal hemorrhages accentuated on the right side.

Due to the strong suspicion of nonaccidental head trauma, radiographs of the upper arms, the spine and the whole legs were taken, in which there was no evidence of a fresh or older consolidated bone injury. Thorax and lower arms were not radiologically included.

A metabolic diagnosis to exclude glutaric aciduria was inconspicuous. There were also no laboratory indications of a relevant coagulation disorder.

Forensic medical course

During a forensic medical examination 1 day after the suspected incident, only a 2 cm large, greenish fading hematoma on the right cheek was visible. Following the examination, further written forensic medical reports were prepared. One report covered two related questions on whether the findings could have been caused by possible cramping or by a minor accident about 3 months before admission to the clinic; both questions were answered negatively. Another medical report was prepared on the question of whether there was mortal danger, which was answered positively.

Early clinical course

The clearly space-consuming character of the bleeding indicated an emergency hematoma evacuation. The neurosurgeons performed a minihole retraction on both sides, an extensive irrigation and subsequent drainage.

One day after the neurosurgical procedure, a discrete anisocoria appeared on the left side, larger than that on the right side, and a deviation of the gaze to the left side was observed. A cranial magnetic resonance imaging (cMRI) (■ Fig. 2) was therefore performed. It showed a new delimitable cortical diffusion disturbance on the right occipital pole, most likely ischemic. The ophthalmological findings were stable.

Multiple ophthalmological checks were then performed. Since the pupil reaction to light was still as sluggish and hesitant as on admission day and there was no pupil reaction during the checks, there appeared to be no changes in the

Fig. 1 ▲ Computed tomography (CT) of the head in different layers with bilateral right anterior chronic subdural hematoma (a, b) and fresh parafalcine subdural hematoma (a) with a maximum width of 0.9 cm and different density values. The furrow relief is bilaterally diminished

Fig. 2 ▲ Magnetic resonance imaging (MRI) of the head (3 T field strength using the head coil) with right temporo-occipital cortical diffusion disturbance (a) and subdural hematoma over the right hemisphere with emphasis on right parafalcine (b). Narrow bifrontal hygroma with inserted subdural drains can be seen on both sides. No cerebral pressure signs, no cerebrospinal fluid circulation disturbance and no cerebral edema are visible

retinal findings. Flash visual evoked potentials (VEP) (■ Fig. 3) were absent so a cortical visual impairment was also discussed.

Later clinical course

A new, centrally localized vitreous haemorrhage appeared on both sides 3 weeks after hospital admission, obscuring the optic disc and macula most probably due to a breakthrough of sub-internal limiting membrane (ILM) hemorrhage into the vitreous cavity. The peripheral retina was covered with persistent intraretinal hemorrhages. Since the occipital cortical ischemia diagnosed by MRI initially led to the assumption of a mainly central

visual disturbance, no therapeutic indication was given at the time.

Follow-up 4 weeks later revealed neither monocular nor binocular fixation and a pendular nystagmus with mixed pattern jerk waves. Pupils were still in moderate mydriasis and neither direct nor indirect light reaction was detectable. Ophthalmoscopy revealed a dense and organized vitreous hemorrhage occupying the optic disc and macula. The peripheral retina was attached with resolving intraretinal haemorrhages. An interdisciplinary team decided to promptly perform a pars plana vitrectomy to remove the hemorrhage obstructing vision and avoid deprivation amblyopia. A 23-gauge pars plana vitrectomy was per-

formed first on the right eye (■ Figs. 4 and 5) and soon after on the left eye. During surgery, epiretinal membranes were found on both sides as a sign of proliferative vitreoretinal reaction (PVR), which indicated a massive damage to the retinal barrier. Subsequently, the left eye developed aggressive proliferative vitreoretinopathy with retinal detachment, so that further retinal surgery became necessary. In the right eye, repeated pars plana vitrectomy had to be performed due to postoperative hemorrhage and PVR.

Due to a relocation, further operations were performed at a different eye centre. Due to increasing lens opacity, a pars plana lensectomy without implantation of an alloplastic lens was necessary on the left eye. Ultimately a sulcus-fixed posterior chamber lens was implanted in the left eye.

The last examination was performed at the age of 21 months. No image fixation or reaction to visual stimuli could be detected. There was a horizontal pendular nystagmus of very variable amplitude and an anisocoria larger on the right than on the left pupil. Light reaction was neither directly nor indirectly triggerable. Retinal findings were described as stable.

Legal course

During the criminal proceedings at court, a forensic medical expert was heard on the question of the origin of the injury. In the course of the proceedings, a minor accident was indicated as an alternative cause, but this did not provide a plausible explanation for the injuries.

Only the child's mother could be considered a suspect, as she was a single parent and stated that the child had not been cared for by others. She was initially charged on suspicion of grievous bodily harm, then, in the course of the investigation, she was charged with grievous bodily harm (§226 Strafgesetzbuch, StGB, German Penal Code). The trial took place first at the local court, later at the regional court, as it was established during the first main hearing at the local court that a manslaughter conviction would also be possible. In the main hearing, the accused did not comment on the substance

of the case; only in the course of previous investigations had she repeatedly stated that she had not shaken the child.

On the basis of the evidence, not least due to several medical and forensic expert opinions, she was sentenced to 3 years and 6 months for aggravated bodily harm in the commission of a crime involving dangerous bodily injury. A petition for review was dismissed as inadmissible.

Discussion

The present case is an example of the course of an unusually pronounced ophthalmological involvement in a case of AHT. When the infant was first presented at the eye clinic, both eyes showed massive subhyaloidal preretinal hemorrhages at the posterior pole and massive disseminated intraretinal hemorrhages on the entire fundus. These pronounced bilateral multilayer retinal hemorrhages are often described after child abuse [14]. Besides a complexity of retinal hemorrhages, it is also suspicious if the posterior pole and the periphery of the retina are involved [14], as in the present case.

Retinal hemorrhage diagnoses that should be considered are either of a traumatic nature, such as birth trauma related to birth modality, or high-impact accidental traumas, such as car accidents [15] or they are from critical illness, such as infections and septicemia, vasculitis, leukemia, Henoch-Schönlein purpura, endocarditis and many others [12, 16–18]. The latter cases are rare in the AHT age range [12]. Reports also indicate that an AHT can cause unilateral retinal hemorrhaging [18, 19].

An overview of vitreous hemorrhages in the pediatric age group is given by Naik et al. [20]. The proportion of patients with bilateral vitreous hemorrhaging and the most common causes differ between different studies [20]. In the western literature [21] nonaccidental trauma or the battered baby syndrome appears to be the most common cause [20], followed by anecdotal reports of various ocular and systemic conditions such as vasculitis [22] or low platelet levels [23, 24]. Also, the age on presentation varies depending on the diagnosis, with

Rechtsmedizin 2021 · 31:457–462 <https://doi.org/10.1007/s00194-021-00460-1>
© The Author(s) 2021

C. Eddahabi · Y. Djalali-Talab · S. Banaschak · K. Feld

Unusual eye injury related to abusive head trauma

Abstract

Ophthalmological examination is an essential component in clinically diagnosing abusive head trauma (AHT). Typical of AHT injuries is retinal bleeding, with other parts of the eye sometimes also being affected. Visual impairment and blindness are long-term complications in this context. We present a case with unusual eye injuries after a diagnostically confirmed AHT. The ophthalmological findings on admission day showed a massive subhyaloid hemorrhage at the posterior pole and extensive flame-shaped intraretinal hemorrhages accented on the right side. A centrally localized vitreous hemorrhage appeared on both sides 3 weeks later, obscuring the optic disc and macula most probably due to a breakthrough of a sub-internal limiting membrane (ILM) hemorrhage into

the vitreous cavity. Follow-up 4 weeks later revealed a dense and organized vitreous hemorrhage occupying the optic disc and macula so that a pars plana vitrectomy was performed on both eyes. The bilateral bleeding in different retinal layers, the vitreous hemorrhage and the proliferative vitreoretinal reaction (PVR) indicated massive damage caused by a significant acceleration-deceleration trauma. A two-phase vitreous hemorrhage in a child with AHT does not yet appear to have been described in the literature.

Keywords

Retinal bleeding · Blindness · Multiple stage · Vitreous hemorrhage · Proliferative vitreoretinal reaction

Ungewöhnliche Augenverletzung im Zusammenhang mit einem missbräuchlichen Kopftrauma

Zusammenfassung

Eine augenärztliche Untersuchung ist wesentlicher Bestandteil der klinischen Diagnose eines misshandlungsbedingten Kopftraumas (AHT). Typisch ist hier das Auftreten von Netzhautblutungen, obwohl seltener auch andere Teile des Auges betroffen sein können. Sehbehinderung und Blindheit sind in diesem Zusammenhang Spätkomplikationen. In diesem Beitrag wird ein Fall mit ungewöhnlichen Augenverletzungen nach einem diagnostisch gesicherten AHT vorgestellt. Der ophthalmologische Befund am Tag der Aufnahme zeigte eine massive subhyaloidale Blutung am hinteren Pol sowie ausgedehnte flammenförmige intraretinale Blutungen betont auf der rechten Seite. Drei Wochen später zeigten sich beidseitig zentral lokalisierte Glaskörperblutungen, die den Sehnervenkopf und die Makula verdunkelten, höchstwahrscheinlich aufgrund eines Durchbruchs einer Sub-ILM-Blutung („internal

limiting membrane“) in den Glaskörperraum. Bei der Nachuntersuchung vier Wochen später zeigte sich eine dichte und organisierte Glaskörperblutung, die den Sehnervenkopf und die Makula bedeckte, so dass in beiden Augen eine Pars-plana-Vitrectomie durchgeführt wurde. Die bilateralen Blutungen in verschiedenen Netzhautschichten, die Glaskörperblutung und die PVR-Reaktion (proliferative vitreoretinale Retinopathie) deuten auf eine massive Schädigung durch ein signifikantes Beschleunigungstrauma hin. Insbesondere die zweiphasige Glaskörperblutung bei einem Kind mit AHT wurde in der gängigen Literatur wohl noch nicht beschrieben.

Schlüsselwörter

Netzhautblutung · Blindheit · Mehrstufig · Glaskörperblutung · Proliferative vitreoretinale Reaktion

shaking trauma (mean age = 0.6 years) and birth trauma (mean age = 0.1 years) for the youngest and pars planitis (mean age = 10.0 years), nonpenetrating trauma (mean age = 10.8 years) and penetrating trauma (mean age = 9.9 years) for older children [21]. According to Spirn et al. 2006, the most common diagnosis with

bilateral presentation was an AHT in the sense of a shaking trauma. All patients with an AHT were diagnosed with bilateral hemorrhage and, conversely, 50% of cases with bilateral hemorrhage were diagnosed with an AHT [21].

Uncommon in this case was the new, centrally localized vitreous hemor-

Fig. 3 ▲ Flash visual evoked potential (top 1.4 Hz, below 8 Hz) shows extinguished visually evoked potentials

Fig. 4 ▲ Intraoperative picture; the dense PVR membrane is removed with a crocodile instrument

Fig. 5 ▲ Intraoperative picture; massive PVR reaction located in the area of the optic disc. The optic disc is not recognizable. Retinal hemorrhage below the PVR reaction

rhage, which appeared on both sides 3 weeks after hospital admission. A search (PubMed) did not reveal any published case describing a two-phase vitreous hemorrhage in a child with AHT. There was no evidence of a second trauma. We suggest that the second vitreous hemorrhage might have been caused by the PVR. Spontaneous vitreous hemorrhage is most commonly caused by proliferative diabetic retinopathy, retinal tear, proliferative retinopathy after retinal vein occlusion and posterior vitreous detachment without retinal tear [25]. Vitreous hemorrhaging can be caused by the pathologic mechanisms of disruption of normal retinal vessels, bleeding from diseased retinal vessels or abnormal new vessels, and extension of

hemorrhaging through the retina from other sources [25]. As PVR is known to be a risk factor for developing vitreous hemorrhage and other differential diagnosis could be excluded, PVR is the most likely cause for the second vitreous hemorrhage. Resulting blindness is a rare complication, especially when caused by factors in the eye itself and not by occipital cortical damage or optic nerve injury, which is more common [2].

The bilateral bleeding in different retinal layers, the vitreous hemorrhage and the PVR reaction indicate massive damage caused by a significant acceleration-deceleration trauma. With overwhelming probability, a massive acceleration-deceleration trauma was the cause of the bleeding in both eyes and the cause of lasting blindness.

Conclusion

- The bilateral bleeding in different retinal layers, the vitreous hemorrhage and the PVR reaction indicate massive damage caused by a significant acceleration-deceleration trauma.
- Two-phase vitreous hemorrhaging in a child with AHT does not appear to have been described in the available literature.
- PVR is known to be a risk factor for developing vitreous hemorrhage.
- Resulting blindness is a rare complication, especially when caused by factors in the eye itself and not by occipital cortical damage or optic nerve injury, which is more common.

Corresponding address

Dr. med. Katharina Feld
Institute of Legal Medicine,
Medical Faculty, University of
Cologne
Melatengürtel 60/62,
50823 Cologne, Germany
katharina.feld@uk-koeln.de

Funding. Open Access funding enabled and organized by Projekt DEAL.

Compliance with ethical guidelines

Conflict of interest. C. Eddahabi, Y. Djalali-Talab, S. Banaschak and K. Feld declare that they have no competing interests.

This article does not contain any studies with human participants or animals performed by any of the authors. Informed consent was obtained from all patients identifiable from images or other information within the manuscript. In the case of underage patients, consent was obtained from a parent or legal guardian.

Open Access. This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0/>.

References

1. Kinderschutzeleitlinienbüro AWMF S3+ Leitlinie Kindesmisshandlung, -missbrauch, -vernachlässigung unter Einbindung der Jugendhilfe und Pädagogik (Kinderschutzeleitlinie), Kurzfassung 1.0, 2019, AWMF-Registernummer: 027-069. https://www.awmf.org/uploads/tx_szleitlinien/KF_027-069k_Kinderschutz_2018-10.pdf. Accessed 3 Feb 2020 (p. 38)
2. Levin AV, Christian CW, Committee on Child Abuse & Neglect (2010) The eye examination in the evaluation of child abuse. *Pediatrics* 126:376–380
3. Levin AV, Luyet FM, Knox B (2016) Ophthalmologic concerns in abusive head trauma. *J Fam Viol* 31:797–804
4. Levin AV (2010) Retinal hemorrhage in abusive head trauma. *Pediatrics* 126:961–970
5. Bhardwaj G, Chowdhury V, Jacobs MB, Moran KT, Martin FJ, Coroneo MT (2010) A systematic review of the diagnostic accuracy of ocular signs in pediatric abusive head trauma. *Ophthalmology* 117:e917
6. Binenbaum G, Mirza-George N, Christian CW, Forbes BJ (2009) Odds of abuse associated with retinal hemorrhages in children suspected of child abuse. *J AAPOS* 13:268–272
7. Morad Y, Kim YM, Armstrong DC, Huyer D, Mian M, Levin AV (2002) Correlation between retinal abnormalities and intracranial abnormalities in the shaken baby syndrome. *Am J Ophthalmol* 134:354–359
8. Kivlin JD, Simons KB, Lazoritz S, Ruttum MS (2000) Shaken baby syndrome. *Ophthalmology* 107:1246–1254
9. Pierre-Kahn V, Roche O, Dureau P, Uteza Y, Renier D, Pierre-Kahn A, Dufier JL (2003) Ophthalmologic findings in suspected child abuse victims with subdural hematomas. *Ophthalmology* 110:1718–1723
10. Mills M (1998) Funduscopy lesions associated with mortality in shaken baby syndrome. *J AAPOS* 2:67–71
11. Binenbaum G, Christian CW, Ichord RN, Ying GS, Simon MA, Romero K, Pollock AN, Forbes BJ (2013) Retinal hemorrhage and brain injury patterns on diffusion-weighted magnetic resonance imaging in children with head trauma. *J AAPOS* 17:603–608
12. Binenbaum G, Forbes BJ (2014) The eye in child abuse: Key points on retinal hemorrhages and abusive head trauma. *Pediatr Radiol* 44:571–577
13. McCabe CF, Donahue SP (2000) Prognostic indicators for vision and mortality in shaken baby syndrome. *Arch Ophthalmol* 118:373–377
14. Watts P, Maguire S, Kwok T, Talabani B, Mann M, Wiener J, Kemp A (2013) Newborn retinal hemorrhages: a systematic review. *J AAPOS* 17:70–78
15. Maguire SA, Watts PO, Shaw AD, Holden S, Taylor RH, Watkins WJ, Kemp AM (2013) Retinal haemorrhages and related findings in abusive and non-abusive head trauma: a systematic review. *Eye* 27:28–36
16. Adams GG, Agrawal S, Sekhri R, Peters MJ, Pierce CM (2013) Appearance and location of retinal haemorrhages in critically ill children. *Br J Ophthalmol* 97:1138–1142
17. Hansen JB, Killough EF, Moffatt ME, Knapp JF (2018) Retinal hemorrhages: abusive head trauma or not? *Pediatr Emerg Care* 34:665–670
18. Watts P (2013) Abusive head trauma and the eye in infancy. *Eye* 27:1227–1229
19. Barth T, Altmann M, Batzlsperger C, Jägle H, Helbig H (2020) Unilateral retinal hemorrhage in infants—two cases of shaken baby syndrome? *Ophthalmology* 117:1033–1036
20. Naik AU, Rishi E, Rishi P (2019) Pediatric vitreous hemorrhage: a narrative review. *Indian J Ophthalmol* 67:732–739
21. Spinn MJ, Lynn MJ, Hubbard GB (2006) Vitreous hemorrhage in children. *Ophthalmology* 113:848–852
22. Rishi P, Rishi E, Gupta A, Swaminathan M, Chhablani J (2013) Vitreous hemorrhage in children and adolescents in India. *J AAPOS* 17:64–69
23. Pathengay A, Das MK, Shah GY (2011) Spontaneous bilateral peripapillary, subhyaloid and vitreous hemorrhage with severe anemia secondary to idiopathic thrombocytopenic purpura. *Indian J Ophthalmol* 59:409–411
24. Majji AB, Bhatia K, Mathai A (2010) Spontaneous bilateral peripapillary, subhyaloid and vitreous hemorrhage with severe anemia secondary to idiopathic thrombocytopenic purpura. *Indian J Ophthalmol* 58:234–236
25. Spraul CW, Grossniklaus HE (1997) Vitreous haemorrhage. *Surv Ophthalmol* 42:3–39

Hier steht eine Anzeige.