Accepted Manuscript

Comparison of the characteristics of retinal hemorrhages in abusive head trauma versus normal vaginal delivery

So Young Kim, MD, Linda A. Morgan, OD, Andrew J. Baldwin, MD, Donny W. Suh, MD

PII: S1091-8531(17)30129-5

DOI: 10.1016/j.jaapos.2017.12.006

Reference: YMPA 2801

To appear in: *Journal of AAPOS*

Received Date: 9 February 2017

Revised Date: 6 December 2017

Accepted Date: 19 December 2017

Please cite this article as: Kim SY, Morgan LA, Baldwin AJ, Suh DW, Comparison of the characteristics of retinal hemorrhages in abusive head trauma versus normal vaginal delivery, *Journal of AAPOS* (2018), doi: 10.1016/j.jaapos.2017.12.006.

Comparison of the characteristics of retinal hemorrhages in abusive head trauma versus normal vaginal delivery

So Young Kim, MD,[a] Linda A. Morgan, OD,[a] Andrew J. Baldwin, MD,[b] and Donny W. Suh, MD[a,b]

Author affiliations: [a]Children's Hospital and Medical Center, Omaha, Nebraska; [b]University of Nebraska Medical Center, Omaha, Nebraska

Submitted March 14, 2017.
Revision accepted December 13, 2017.

Correspondence: Linda A. Morgan, OD, Children's Hospital & Medical Center, 8200 Dodge St, Omaha, NE 68114 (email: limorgan@childrensomaha.org).

Word count: 2,835
Abstract only: 256

Abstract

Background

Retinal hemorrhage (RH) is one of the hallmarks of abusive head trauma (AHT); however, RH is also encountered with normal vaginal deliveries (NVD) and thus presents the clinician with a diagnostic dilemma. The purpose of this study was to compare RHs in AHT with those of NVD.

Methods

Records of with AHT and NVD infants with RH evaluated from 2013 to 2015 were reviewed retrospectively. Pattern, size, extent, and severity were compared using RetCam images. Severities were calculated using the RH grading scale.

Results

A total of 20 patients with AHT and 200 NVD infants were included. RH size was significantly larger in AHT patients compared to the NVD group (3.1 ± 0.512 vs 0.96 ± 0.046 disk diameters, resp.). The AHT group also demonstrated a higher RH incidence involving all three retinal layers compared to the NVD group (60% vs 0.6%, resp. [$P < 0.001$]). Vitreous hemorrhages were more common in the AHT group compared to the NVD group (54.3% vs 1.5% [$P < 0.001$]). Also, the grading scale demonstrated higher scores in the AHT group than the NVD group (7.15 ± 0.948 vs 3.59 ± 0.274, resp.).

Conclusions

AHT and NVD share similar retinal findings, but they also have unique differentiators. In our subjects, AHT presented with more severe retinal findings than NVD, including larger RH size, a higher percentage involving all three retinal layers, a higher percentage of vitreous hemorrhages, and higher RH grading scale scores. Also, NVD retinal hemorrhages resolved quickly, within 4 weeks of birth in 95% of the patients.

Retinal hemorrhage (RH) in infants and young children is not common, and although nonspecific, RH may be the presenting sign of underlying diseases or disorders. Potential causes of RH in infants include abusive head trauma, leukemias, blood and coagulation disorders, and occasionally intracranial hemorrhages. RH at birth may also occur after normal vaginal deliveries (NVD).

Abusive head trauma (AHT) is the most common type of child abuse and the leading cause of death among victims of child abuse, with the peak incidence in infants <6 months of age and a rate of 14%-25%.[1,2] First described as whiplash shaken infant syndrome, Caffey[3] described a classic triad of findings: subdural hematomas, RHs, and metaphyseal fractures. A policy statement by the American Academy of Pediatrics later advocated for the use of the term AHT to describe inflicted injury to the head of an infant or child, whether by violent shaking, blunt impact, or both.[4] Kiffney[5] discussed the ocular complications resulting from child abuse, of which RH is the most common. As a cardinal feature of AHT, RHs are reported to be present in 50%-100% of cases.[6] Nevertheless, when evaluating for a possible diagnosis of AHT, multiple differentials should be considered, given that AHT itself is a complex diagnosis with significant social, legal, and medical implications.

RH can also be encountered in neonates born via normal vaginal delivery, with a reported incidence of 2.6%-50%. This wide disparity is in part due to varied patient demographics, differences in timing of newborn examinations, and varying examination techniques used by clinics and hospitals.[7,8] The severity of hemorrhages varies considerably and different morphologies of hemorrhage are seen. However, in general, birth-related RHs are typically less severe, resolve quickly, and do not cause later visual sequelae.

There are specific patterns and characteristics of RHs associated with AHT and NVD that

are important to consider when determining a diagnosis. Clinicians who suspect abusive hemorrhage also must recognize the possibility of RH in neonates delivered via normal vaginal deliveries. A false negative diagnosis of AHT may leave some children at risk for further abuse and trauma, whereas a false positive diagnosis of AHT may result in unwarranted and harmful consequences to parents and children. This study aimed to analyze the pattern of RH in both groups and elucidate differences that may aid clinicians to discern between true AHT and RH.

Subjects and Methods

Ethical approval for this study was granted by the University of Nebraska Medical Center Institutional Review Board and Soonchunhyang University Cheonan Hospital Institutional Review Board. The medical records of all cases of suspected AHT from 2013 to 2015 in which the Children's Pediatric Ophthalmology Service was consulted to evaluate possible child abuse of patients seen at Omaha Children's Hospital and Medical Center were reviewed retrospectively. A total of 165 cases were submitted. AHT was defined as an injury to the skull or the intracranial contents of an infant or young child caused by inflicted blunt impact or blunt impact and violent shaking.[9] Although there is no universally accepted reference standard for the diagnosis of AHT, 31 patients were confirmed as AHT by one child abuse specialist, who considered not only clinical features but also circumstances, including perpetrator confession, witnesses to the abuse, and cases that had been confirmed during legal proceedings. Patients whose injuries had been documented with RetCam (Clarity Medical System, Pleasanton, CA) fundus photographs were enrolled in this study (AHT group). The following information was also extracted from the medical record: sex, age at examination, medical history, physical examination findings, and radiographic studies.

The Universal Newborn Eye Screening (NES) was a prospective institutional cohort

study conducted at Soonchunhyang University Cheonan Hospital (SUCH), South Korea (SUCH NES) . Twenty-nine local obstetric hospitals participated in this study from October 1 to October 14, 2015

The SUCH-NES study was designed to determine the prevalence of eye problems in normal, healthy newborns. Neonates admitted to an intensive care unit, transferred to a tertiary care children's hospital, or having known or suspected systemic or ocular disease were excluded. The families of the neonates were informed about the option to have eye screening examinations for their newborns. If the parents wanted the examination, they were educated about the examinations and signed informed consent forms.

Initial examinations by nurses or medical staff at each hospital were performed within 7 days of birth. Although intraretinal hemorrhages may resolve within 7 days of the original insult, all patients were screened during the same time period using identical testing specifications. With consent, pupils were dilated and RetCam widefield digital images and external red reflex images were obtained. Retinal and external eye images were sent to the reading center at SUCH and reviewed by a pediatric eye specialist (SYK), who returned the results to each hospital. If RHs were present, details of the birth were obtained, including sex, age at screening (days), birth weight, gestational age, Apgar scores, and birth method (vaginal vs Cesarean section). The examination was repeated for each infant once every month until all RHs had resolved.

Analysis of RHs

Retinal images were taken using the RetCam III in both groups. Retinal images in both groups were reviewed and the data were recorded by a pediatric ophthalmologist. The following factors were collected and compared between the AHT and NVD groups: number of RHs, size of the largest RH, involved retinal layers, involved zone, involvement of macula and/or optic nerve,

and accompanied vitreous hemorrhage. Areas of retinal involvement were the commonly defined zones I, II, and III of retinopathy of prematurity.[10] RH severity was assessed using a grading scale similar to that described by Binenbaum and colleagues (Table 1).[6] RHs were scored according to the size, location, and extent of layer involvement.

Data was analyzed using SPSS for Windows statistical software version 21.0 (SPSS Inc, Chicago, IL). Variables were analyzed for statistical significance through exact χ^2 testing of independence.

Results

A total of 20 children with AHT met inclusion criteria and were enrolled. A total of 730 healthy neonates underwent eye screening examination in South Korea. Of these, 200 cases (27.4%) demonstrated RHs and were enrolled in this study. Patient demographic features of the patients of both groups are provided in Table 2. There was no significant difference in the male/ female ratio between groups. In the AHT group, mean age was 0.5 years of age; in the NVD group, 1.6 days. All neonates in the NVD group were examined within 7 days after birth. All patients in the AHT group demonstrated one or more other significant features, including epidural hemorrhage, loss of consciousness, and seizure (100%) in comparison to the NVD group (0%; $P < 0.0001$). Details are listed in Table 3.

In the AHT group, 15 patients (75%) had RHs in both eyes and 5 (25%) had RHs in one eye. Of the 5 patients with unilateral RH, 3 (60%) had RHs in right eye and 2 (40%) had RHS in left eye. In the NVD group, 133 neonates (66.5%) had RHs in both eyes and 67 (23.5%) had RHs in one eye. Of the 67 neonates with unilateral RHs, 42 (62.7%) had RHs in the right eye and 25 (37.3%) had RHs in the left eye. There was no statistically significant difference in laterality for either group ($P = 0.618$). RH characteristics of both groups are provided in Table 4.

The size of individual RHs was significantly larger in the AHT group compared to the NVD group (3.1 ± 0.512 vs 0.96 ± 0.046 disk diameters, resp. [$P < 0.001$]). In particular, RHs larger than 2 disk diameters were found in 20 eyes (57.2%) in the AHT group versus only 39 eyes (11.7%) in the NVD group ($P < 0.01$).

The AHT group demonstrated a higher incidence of RHs involving all three retinal layers compared to the NVD group (60% vs 0.6%, resp. [$P < 0.01$]). In the AHT group, only 6 eyes (17.1%) had hemorrhage limited to the intraretinal layer, whereas in the NVD group, 307 eyes (92.2%) had intraretinal hemorrhage only.

The AHT group also demonstrated a higher incidence of macula and optic nerve involvement (88.6% vs 60.7% resp. [$P < 0.01$]). Both the macula and optic nerve were involved in 27 eyes (77.2%) in the AHT group and in 103 eyes (30.93%) in the NVD group. Vitreous hemorrhages were encountered more commonly in the AHT group (54.3%) compared to the NVD group (1.5% [$P < 0.001$]). Overall, the AHT group demonstrated higher grading scores than the NVD group (7.15 ± 0.948 vs 3.59 ± 0.274, resp.).

The number of RHs and involved zones did not differ significantly between groups ($P = 0.495$ [AHT], $P = 0.034$ [NVD]). Four eyes in the AHT group (11.4%) had optic nerve edema; no optic nerve edema was detected in the NVD group.

In the NVD group, RHs underwent repeat examination at 4 weeks following initial examination and were followed up at 4-week intervals until RHs resolved completely. A total of 149 patients (262 eyes) underwent the 4-week reexamination. RHs were resolved completely in 141 patients (94.6%) and 252 eyes (96.2%). In only one severe case with vitreous hemorrhage did RHs require 12 weeks to resolve.

Discussion

AHT is the most common cause of death due to child abuse and the most common cause of traumatic death in children <12 months of age.[11] Because the majority of victims are <2 years of age and are nonverbal, up to 30% of cases of AHT may initially go unrecognized.[12] AHT also causes significant neurological morbidity, with more than 80% of survivors having permanent sequelae in the form of motor, intellectual, and visual deficits, including blindness.[2,13,14]

Clinical characteristics of AHT have been studied extensively, with RHs considered consistent with a diagnosis of AHT, especially in children with little external evidence of trauma and poorly documented history. Previous studies have demonstrated that RHs found in AHT patients are typically bilateral, numerous, and extend to the periphery of the retina. In addition, when these extensive hemorrhages cover the macula, optic nerve, or both, a diagnosis of AHT is highly suggestive.[15,16]

However, normal vaginal delivery (NVD) is considered the most common cause of RHs in infants.[6] Studies show that up to 50% of normal, full-term babies examined within 24 hours of birth had RHs.[17] Most authors suggest that RHs associated with NVD are very common, though these are typically intraretinal and limited to the posterior pole. These hemorrhages are quick to resolve, usually by 4 weeks, and very rarely persist beyond 6 weeks (see Figure 1).[18,19] However, several cases of severe RHs have been reported to present with large or deep intraretinal hemorrhages that lasted up to 58 days and were also accompanied by vitreous hemorrhage that lasted up to 3 months.[7,18] Therefore, in some severe cases, distinguishing retinal hemorrhages between NVD and AHT prior to 4 weeks of age could prove difficult and must be evaluated in conjunction with other clinical findings.

In the current study, RHs in the AHT group presented with significantly more severe retinal findings: they were more likely to involve the macula, optic nerve, and all three layers of

the retina and were more likely to be accompanied by vitreous hemorrhage (Figure 2). Overall, the AHT group had higher RH grading scale at 7.15 ± 0.948 with significantly greater severity of RHs in comparison to the NVD at 3.59 ± 0.274 ($P < 0.01$). In contrast, RHs in the NVD group were smaller in size and most commonly only involved the intraretinal layer.

Although bilateral, extensive hemorrhages have been indicative of AHT in previous studies, the results from this study suggest that the number of RHs and zones involved are less predictive of AHT than RH size, involved retinal layers, and the presence of vitreous hemorrhage. In the AHT cases, 57.2% of patients had RHs that were 2 disk diameters or larger, whereas 11.7% NVD patients had RHs of the same size. In addition, 60% of AHT patients had hemorrhages in all retinal layers compared to 1.5% of NVD patients having all retinal layers affected. Additionally, the presence of vitreous hemorrhages was in 54.3% of AHT patients and 1.3% of NVD patients. The number of RHs, involved zones, extension to the periphery, and bilaterality were not statistically different between AHT and NVD.

The clinical difference in the RHs may be based on pathophysiological differences. The major mechanism of injury in AHT is thought to be rapid and repetitive acceleration-deceleration caused by violent shaking, resulting in vitreoretinal traction at areas of firm vitreous attachment to the retina. Another possible mechanism is direct trauma resulting from increased intracranial pressure, inducing vascular compression. However, the characteristics of injury may be the result of a combination of one or more mechanisms.[7,18,19]

Conversely, while poorly understood, the mechanism of RHs during natural birth may be related to mechanical stress. Acute compression of the head increases intracranial pressure within the birth canal to create RHs in infants during NVD.[20] Other proposed mechanisms under investigation are prostaglandins in the fetal circulation, altered blood viscosity, and possibly

neonatal coagulopathy. [21,22]

The pathophysiology difference between the AHT group and the NVD group is intricately linked to the resultant retinal pathology. The NVD group has unidirectional, translational force on the head and retina, whereas the AHT group has repetitive acceleration and deceleration. Therefore, RHs in AHT are more likely to have more severe ocular features than those in the NVD group, including the presence in all retinal layers secondary to stress on the vitreoretinal interface and resultant breakage of the inner, middle, and outer retinal vasculatures. Also, the deep RHs in AHT are likely to resolve more slowly than those of NVD because of their extensive nature.[23]

In contrast, due to the acute translational force on the heads, the infants in the NVD group had milder retinal pathologies. Of the 333 eyes in the NVD group, 92.2% of the patients had RHs in the intraretinal layer only, and 98.5% had no vitreous hemorrhages. In addition, 95% of the NVD eyes had resolution of ocular findings within 4 weeks.

Children in the AHT group also had at least one accompanying neurological finding, including subdural hematoma, loss of consciousness and seizure. Of these, subdural hematoma was found in 95% of patients, which is consistent with other studies in observing that the most common intracranial injury in AHT is subdural hemorrhages.[23,24] However, AHT-related RH can occur without any intracranial findings. In addition, none of the infants in the NVD group in this study had other signs of injuries except small caput succedaneum that did not require further evaluation.

Limitations of this study include the relatively small sample size and percentage of individuals with RHs. Further studies should evaluate infants within 24 hours of birth, because intraretinal hemorrhages can dissipate prior to the 7-day evaluation that was used in this study.

RHs in AHT and NVD share some common characteristics but have distinctions within each group. In the AHT group, patients were older and RHs were more severe and had larger retinal hemorrhage sizes. In addition, the hemorrhages were more likely to involve all three retinal layers and have associated vitreous hemorrhages and higher RH grading scale scores. In cases where the NVD retinal findings were more extensive than anticipated, resolution could last more than 4 weeks. When severe RHs were discovered in very young newborns, other factors, such as presence of intracranial hemorrahges on neuroimaging, a history of loss of consciousness, and a history of seizures, should be considered when making a diagnosis of AHT.

References

1. Keenan HT, Runyan DK, Marshall SW, Nocera MA, Merten DF. A population-based comparison of clinical and outcome characteristics of young children with serious inflicted and noninflicted traumatic brain injury. Pediatrics 2004;114:633-9.
2. Duhaime A, Christian C, Moss E, Seidl T. Long-term outcome in infants with the shaking-impact syndrome. Pediatr Neurosurg 1996;24:292-8.
3. Caffey J. The whiplash shaken infant syndrome: manual shaking by the extremities with whiplash-induced intracranial and intraocular bleedings, linked with residual permanent brain damage and mental retardation. Pediatrics 1971;54:396-403.
4. Christian CW, Block R; Committee on Child Abuse and Neglect, American Academy of Pediatrics. Abusive head trauma in infants and children. Pediatrics 2009;123:1409-11.
5. Kiffney GT Jr. The eye of the "battered child." Arch Ophthalmol 1964;72:231-3.
6. Binenbaum G, Mirza-George N, Christian CW, Forbes BJ. Odds of abuse associated with retinal hemorrhages in children suspected of child abuse. J AAPOS 2009;13:268-72.
7. Choi YJ, Jung MS, Kim SY. Retinal hemorrhage associated with perinatal distress in newborns. Korean J Ophthalmol 2011;25:311-16.
8. Li LH, Li N, Zhao JY, et al. Findings of perinatal ocular examination performed on 3573, healthy full-term newborns. Br J Ophthalmol 2013;97:588-91.
9. Niederkrotenthaler T, Xu L, Parks SE, Sugerman DE. Descriptive factors of abusive head trauma in young children--United States, 2000-2009. Child Abuse Negl 2013;37:446-55.
10. International Committee for the Classification of Retinopathy of Prematurity. The International Classification of Retinopathy of Prematurity revisited. Arch Ophthalmol 2005; 123:991-9.

11. Duhaime AC, Christian C, Moss E, Zimmerman RA. Nonaccidental head trauma in infants—the "shaken baby syndrome." N Eng J Med 1999;338:1822-9.

12. Jenny C, Hymel KP, Ritzen A, Reinert SE, Hay TC. Analysis of missed cases of abusive head trauma. JAMA 1999;281:621-6.

13. Barlow KM, Thomson E, Johnson D, Minns RA. Late neurologic and cognitive sequelae of inflicted traumatic brain injury in infancy. Pediatrics 2005;116:e174-85.

14. Keenan HT, Runyan DK, Marshall SW, Nocera MA, Merten DF, Sinal SH. A population-based study of inflicted traumatic brain injury in young children. JAMA 2003;290:621-6.

15. Kivlin JD. Manifestations of the shaken baby syndrome. Curr Opin Ophthalmol 2001;12:158-63.

16. Morad Y, Kim YM, Armstrong DC, Huyer D, Mian M, Levin AV. Correlation between retinal abnormalities and intracranial abnormalities in the shaken baby syndrome. Am J Ophthalmol 2002;134:354-9.

17. Kaur B, Taylor D. Fundus hemorrhages in infancy. Surv Ophthalmol 1992;37:1-17.

18. Hughes LA, May K, Talbot JF, Parsons MA. Incidence, distribution, and duration of birth-related retinal hemorrhages: a prospective study. J AAPOS 2006;10:102-6.

19. Watts P, Maguire S, Kwok T, et al. Newborn retinal hemorrhages: a systemic review. J AAPOS 2013;17:70-78.

20. Schenker JG, Gombos GM. Retinal hemorrhages in the newborn. Obstet Gynecol 1966;27:521-4.

21. Schoenfeld A, Buckman G, Nissenkorn I, Cohen S, Ben-Sira I, Ovadia J. Retinal hemorrhages in the newborn following labor induced by oxytocin or dinoprostone. Arch

Ophthalmol 1985;103:932-4.

22. Pichler E, Pichler L. The neonatal coagulation system and the vitamin K deficiency bleeding—a mini review. Wein Med Wochenschr 2008;158:385-95.

23. Bechtel K, Stoessel K, Leventhal JM, et al. Characteristics that distinguish accidental from abusive injury in hospitalized young children with head trauma. Pediatrics 2004;114:165-8.

24. Thackeray JD, Scribano PV, Lindberg DM. Yield of retinal examination in suspected physical abuse with normal neuroimaging. Pediatrics 2010;125:e1066-71.

Legends

FIG 1. Fundus photographs of neonates with retinal hemorrhages with normal vaginal deliveries. A, Flame-shaped intraretinal hemorrhages with central whitening. B, Typical dot-and-blot intraretinal hemorrhages. C, A severe case with vitreous hemorrhages. D, Extensive intraretinal hemorrhages with involvement macula and optic nerve.

FIG 2. Fundus photographs of infants with abusive head trauma. A, Characteristic intraretinal hemorrhages with central whitening. B, Diffuse intraretinal hemorrhages with preretinal hemorrhages. C, Vitreous hemorrhages with macular involvement as well as some preretinal hemorrhages. D, Extensive vitreous hemorrhages obscuring macula and optic nerve.

Table 1. Retinal hemorrhage grading scale: left and right eyes are assessed separately[a]

Hemorrhage	Points
Type and size (only one category chosen)	
Mild-intraretinal hemorrhages only (≤1 DD)	1
Moderate-subhyaloid hemorrhage present, all lesions less than 2 disk areas in size (1-2 DD)	2
Severe-subhyaloid hemorrhage, vitreous hemorrhage, or any lesion greater than two disk area in size (>2 DD)	3
Extent (sum of categories)	
Any hemorrhage within the following areas	
Macula (within 3 DD of fovea)	1
Peripapillary (within 3 DD of disk)	1
Periphery (outside above the lesion)	1

DD, disk diameter.

[a]Overall score is calculated by combining the total scores for each eye; maximum score is 6 points per eye, or 12 points overall.

Table 2. Demographic features of patients with AHT and NVD infants with RH

	AHT group	NVD group
No. patients (eyes)	20 (35)	200 (333)
Male:female	12:8	97:103
Mean age (range)	0.509 months (range, 1-15)	1.6 days (range, 1-7)
Mean GA	Full term	39+1 weeks (range, 35-41+3)
Other clinical findings (subdural hemorrhage, seizure, bruises, etc)	20 (100%)	0 (0%)

AHT, abusive head trauma; *GA*, gestational age; *NVD*, normal vaginal delivery; *RH*, retinal hemorrhage.

Table 3. Accompanied clinical findings of patients with AHT

Clinical findings	No patients (%)
Subdural hematoma	19 (95)
Loss of consciousness	13 (65)
Seizure	13 (65)
Bruise	4 (20)
Ecchymosis	4 (20)
Macrocephaly	4 (20)
Other fractures (eg, humerus)	4 (20)
Lethargy	4 (20)
Skull fracture	2 (10)
Nausea/vomiting	2 (10)
Abrasion/scar	1 (5)
Weight changes	1 (5)
Burn	1 (5)
Apnea	1 (5)
Hypothermia	1 (5)
Abnormal eye movement	1 (5)

Table 4. Characteristics of retinal hemorrhages in both groups (eyes,%)

		AHT group, no. eyes (%)	NVD group, no. eyes (%)	*P* value
No. of RH spot	<10	6 (17.2)	62 (18.6)	0.495
	10-29	13 (37.1)	138 (41.5)	
	30-50	3 (8.6)	39 (11.7)	
	>50	13 (37.1)	94 (28.2)	
Size of largest spot	<1 DD	9 (25.7)	192 (57.7)	<0.001
	1-2	6 (17.1)	102 (30.6)	
	2-5	12 (34.3)	38 (11.4)	
	>5	8 (22.9)	1 (0.3)	
Involved layer	Intraretinal	6 (17.1)	307 (92.2)	<0.01
	Preretinal	8 (22.9)	21 (6.3)	
	Subretinal	0	0	
	All layer	21 (60.0)	5 (1.5)	
Involved zone	Zone I	19 (54.3)	238 (71.5)	0.034
	Zone II			
	Zone III			
	Zone I & II	16 (45.7)	93 (27.9)	
	Zone I-III			
Macula and/or ON involved	Macula+ON	4 (11.4)	103 (30.93)	<0.01
	ON only	27(77.2)	99 (29.73)	
	None	4 (11.4)	131 (39.34)	
Accompanied VH	Yes	19 (54.3)	5 (1.5)	<0.01
	No	16 (45.7)	328 (98.5)	
RH grading score (mean)	Each eye	4.09	2.24	<0.01
	Both eye	7.15	3.59	<0.01

AHT, abusive head trauma; *DD*, disk diameter; *NVD*, normal vaginal delivery; *ON*, optic nerve; *RH*, retinal hemorrhages; *VH*, vitreous hemorrhage.