Incidence, Distribution, and Duration of Birth-Related Retinal Hemorrhages: A Prospective Study

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Background: Retinal hemorrhages secondary to birth trauma are part of the differential diagnosis of intraocular hemorrhages seen in the setting of Shaken baby syndrome in very young infants. This prospective study aimed to document the morphology, distribution and, most importantly, the natural history of these hemorrhages using digital imaging. **Subjects and methods:** Infants were recruited as soon after birth as possible and examined by indirect ophthalmoscopy. Retinal hemorrhages were photographed using the RetCam 120. Birth history was documented from the medical notes. Infants were reexamined and photographed until hemorrhages had resolved. **Results:** Data were analyzed for a total of 53 neonates. The number of infants with retinal hemorrhage was 18 (34%). The incidence in relation to mode of delivery was as follows: vacuum delivery, 77.8%; normal vaginal delivery, 30.4%; cesarean section, 8.3%; forceps delivery, 30.3%. All hemorrhages were intraretinal and in all but two infants hemorrhages had resolved by 16 days. In two subjects hemorrhages were still present at 31 and 58 days, respectively. Both these infants were delivered by vacuum delivery. **Conclusions:** The RetCam 120 provides excellent documentation of retinal hemorrhages and their natural history. We have demonstrated hemorrhages still present at 58 days in a child born by vacuum delivery and this may have important implications for consideration in the differential diagnosis of Shaken baby syndrome. (J AAPOS 2006;10:102-106)

It is well known that retinal hemorrhages occur in newborn infants during delivery. The reported incidence varies from 2.6 to 50%.[1,2] This variation appears to be primarily due to when infants are examined after birth. Giles[3] demonstrated that the incidence was reduced from 40% at 1 hour postdelivery to 20% at 72 hours. Sezen[4] found the incidence was only 2.6% after 3 to 5 days. Experience of the examiner, mode of examination (direct versus indirect ophthalmoscopy), and use of a speculum are also thought to contribute to this variation.[1,2,5] The incidence varies with mode of delivery. They occur most frequently in those delivered by vacuum extraction (75%); 33% in those delivered by spontaneous vaginal delivery; and 6.7% by cesarean section.[2] These figures concur with those of other authors.[6,7]

The severity of the hemorrhages varies considerably and different morphologies of hemorrhage can be seen. Kaur and Taylor[1] described them as being "usually a mixture of splinter-shaped, flame-shaped and dot and blot hemorrhage, with rare sub retinal and preretinal hemorrhage." Williams et al[6] found flame-shaped hemorrhages, which they graded as moderate (11 to 20 hemorrhages) as well as isolated and confluent blot hemorrhages. These were often larger than 2 disk diameters in size. Emerson et al[2] described grade III severity (>10 hemorrhages) in 54% of all eyes with retinal hemorrhage and in 88% of those infants with bilateral hemorrhages.

Despite the number of articles documenting incidence, type, and severity of these hemorrhages, there are few studies relating morphology, distribution, mode of delivery, and natural history. The pattern of resolution of these hemorrhages has important implications when considering a differential diagnosis of nonaccidental injury or "Shaken baby syndrome." It is important for a clinician, when suspecting child abuse, to know the probability of retinal hemorrhages seen in an infant being nonresolved or resolving birth-related hemorrhage. This prospective study aimed to document the mode of delivery, incidence, distribution, and morphology of birth-related retinal hemorrhage in a cohort of infants and to describe their natural history in relation to these factors.

TABLE 1 Demographic data

	Total Cohort	Infants with Retinal Hemorrhage
Number of infants	53	18
Mean gestational age	39.5 weeks (range 33–42 weeks)	40 weeks (range 39–42 weeks)
Number of males	18	5
Number of females	35	13
Mean age at first examination	1.8 days (range 1–4 days)	1.7 days (range 1–4 days)
Mean maternal age at birth	31 years (range 21–39)	30 years (range 25–36)

TABLE 2 Mode of delivery and incidence of retinal hemorrhage

Mode of Delivery	Number of Infants (% of total)	Number of These with Retinal Hemorrhages (%)
Normal vaginal delivery	23 (43.4)	7 (30.4)
Vacuum delivery	9 (17)	7 (77.8)
Cesarean section all[a]	12 (32)	1 (8.3)
Emergency cesarean section	8 (15.1)	1 (failed vacuum delivery)
Elective cesarean section	4 (7.5)	0
Forceps all[b]	9 (17)	3 (30.3)
Forceps (failed vacuum delivery)	2 (3.8)	2 (11.1)

[a]Including delivery by emergency caesarean section.
[b]Including failed vacuum delivery.

SUBJECTS AND METHODS

Parents of neonates were asked to take part in the study in the maternity units of The Northern General Hospital and Jessop Hospital for Women in Sheffield during a 12-month period (from December 1999 to November 2000). The parents gave written informed consent to the examination of their child.

The first examination was performed at 1 day postdelivery or as close to this as possible (range 1 to 4 days). General external ophthalmic observations were made and documented. Pupils were dilated using 0.5% cyclopentolate and the fundus of each child was examined by indirect ophthalmoscopy. A speculum was only used when a good view was not possible by holding the eyelids open manually. When retinal hemorrhage(s) was present, digital color photographs were taken using the RetCam 120 (Massie Research Laboratories, Inc., Dublin, CA) following instillation of 0.5% proxymetacaine and the use of Viscotears Liquid Gel (Carbomer 2 mg/g; Novartis Pharmaceuticals UK Ltd., Camberley, UK) as an interface between the camera and the cornea. A speculum was used for all photographs. Details of the birth of each child were taken from the medical notes.

Any child with abnormalities found on examination that required urgent referral was referred to the Pediatric Ophthalmologist.

When retinal hemorrhages were present, the child was reexamined between 3 and 9 days, and then on a weekly basis until the hemorrhage(s) had resolved. RetCam 120 images were taken of all retinal hemorrhages on subsequent examinations where possible.

Ethical approval for this study was granted by South Sheffield Research Ethics Committee (ref 98/374).

RESULTS

Sixty infants were examined. Data for seven neonates either were incomplete or were examined in the Special Care Baby Unit (SCBU) and therefore excluded to ensure that the data analysis only included those neonates without systemic conditions. Data were analyzed for a total of 53 neonates.

The number of infants with retinal hemorrhage was 18 (33.96%); 14 were bilateral. Table 1 summarizes the demographic data for the cohort as a total and for those infants found to have retinal hemorrhage. The mean maternal age at birth for those infants without retinal hemorrhage was 28 years (range 21 to 39 years). There was no significant difference between the age of those mothers whose babies had retinal hemorrhage and those whose babies did not ($P = 0.35$, unpaired t-test).

The mode of delivery for all babies examined was as shown with the corresponding incidence of retinal hemorrhage in Table 2.

From the data collected in this study the only significant factor relating to the presence of birth-related retinal hemorrhage was mode of delivery ($P = 0.01$, $\chi^2 = 11.347$, $df = 3$). Vacuum delivery produced significantly more retinal hemorrhages than would be expected by chance and cesarean section produced significantly fewer. Normal vaginal delivery and forceps delivery were at chance levels.

Type and Size of Hemorrhages

All hemorrhages were intraretinal. They ranged in size from 0.5 to 2 disk diameters. As readable photographs were not available for all infants who had hemorrhages, the following figures do not equal the total for the number of eyes with hemorrhage at initial examination in this series:
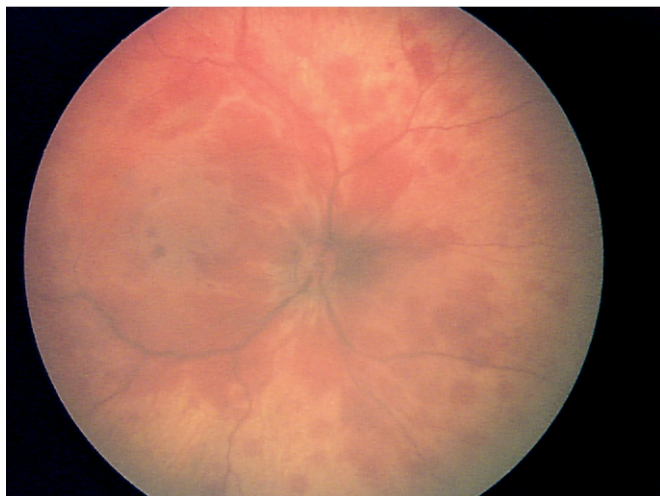
FIG 1. RetCam 120 fundus photograph, 1 day post normal vaginal delivery. Confluent hemorrhages around the optic disk and arcades.

five eyes had 1 to 9 hemorrhages; six eyes had 10 to 19; four eyes had 20 to 29; four had 30 or more; and four eyes had confluent or subconfluent hemorrhage. The number of hemorrhages present did not appear to relate to mode of delivery in this sample. However, numbers are too small to perform meaningful statistical analysis. Confluent hemorrhage tended to be around the discs and arcades but the distribution of hemorrhage was variable (Figure 1). White-centered hemorrhages were present in the retina of three infants.

Duration of Hemorrhages in Relation to Mode of Delivery

The second examination was undertaken between 3 and 9 days postdelivery. Five infants had residual intraretinal hemorrhages; three of these children were delivered by vacuum extraction and two by normal vaginal delivery. Two infants also had dense foveal hemorrhages in one eye. Nine infants had no hemorrhages, and four infants were lost to follow-up at this stage.

Only two infants had hemorrhages remaining at the third examination. These two infants (subjects 49 and 51) were both delivered by vacuum extraction and had foveal hemorrhages that were still present at day 22 (for subject 49) and day 31 (for subject 51). Subject 49 also had intraretinal hemorrhages elsewhere, and these were still present at day 58.

Figure 2A to D shows a series of RetCam 120 images documenting the foveal hemorrhage of the right eye of subject 51, and its resolution.

DISCUSSION

The RetCam 120 is a portable digital imaging system that provides high-resolution real-time images of retinal hemorrhages without the need for sedation or general anesthesia in young children and infants. Traditionally retinal

hemorrhages are documented in a freehand drawing by the examining clinician and, while these drawings are useful, real-time digital photographs provide much better documentation. The RetCam 120 provides a 120-degree field-of-view and therefore peripheral hemorrhages can be also be documented easily and quickly. Many images of the fundus can be taken quickly, providing instant documentation of the extent of retinal hemorrhages. This method has also proved useful in the documentation of the features of Shaken baby syndrome.[8]

During examination with the RetCam 120, there was little evidence of distress from the infants. Both parents and clinical staff in the maternity units found this an acceptable way of examining and documenting retinal hemorrhage in this population. The use of the RetCam 120, in this study, was also invaluable in documenting hemorrhages on subsequent visits as it enabled the type and location of hemorrhage and patterns of resolution to be assessed accurately after the examination.

Table 3 shows the current study's data on incidence of birth-related retinal hemorrhage in relation to previous studies. Interestingly in the current study the one child with retinal hemorrhage delivered by emergency cesarean section had an attempted delivery by forceps, which had failed, and two of the children with retinal hemorrhage who were delivered by forceps had an attempted vacuum delivery before proceeding to forceps. Taking these factors into consideration, our results compare favorably to others. Emerson and coworkers[2] found that not only was vacuum-assisted delivery a significant risk factor for birth-related retinal hemorrhage, but also was increased maternal age. This was not the case for our cohort, although the mean age of mothers of babies with retinal hemorrhage (31 years) was very similar to Emerson's study (29 years).

The number of retinal hemorrhages seen in these infants varied from isolated hemorrhage to confluent patterns. This did not appear to relate to mode of delivery, but larger subject numbers would be needed to be conclusive about this. Williams et al[6] did find a significant relationship between the severity of hemorrhage and mode of delivery, the most risk being associated with sequential vacuum and forceps-assisted deliveries.

A study by Whitby and coworkers[9] investigated the incidence of subclinical subdural hemorrhage following birth. They found an incidence of 8.1% (9 of 111 babies). Three deliveries were normal vaginal deliveries (6.1% risk), five were forceps deliveries following failed vacuum delivery (27.8% risk), and one was a traumatic vacuum delivery (7.7% risk). All hemorrhages resolved by 4 weeks. The authors of this article state that "most, but not all" subclinical subdural hemorrhages were associated with instrumental delivery, and this is also the case for our cohort in relation to retinal hemorrhages. In total, 11 of the 18 babies with retinal hemorrhages had delivery by instrumentation. As stated previously for the one cesarean section in the cohort, forceps delivery had been attempted
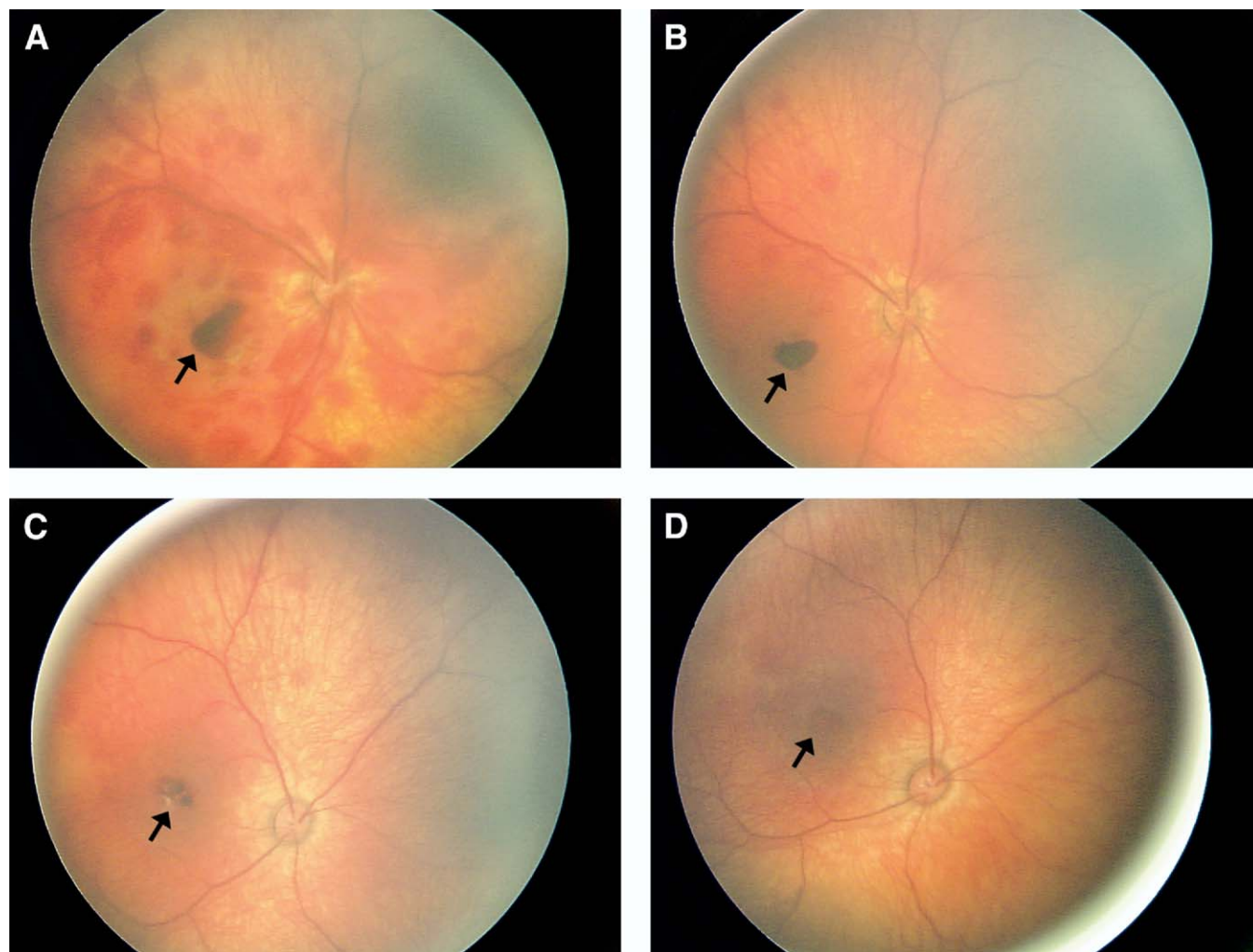
FIG 2. (A) Subconfluent hemorrhage and dense dark foveal hemorrhage (as indicated) at 1 day; (B) resolution of subconfluent hemorrhages at 8 days postdelivery with dense dark foveal hemorrhage remaining; (C) white centered foveal hemorrhage still present at 30 days postdelivery; (D) resolution of foveal hemorrhage, photograph taken 57 days postdelivery.

TABLE 3 Incidence of retinal hemorrhage in relation to mode of delivery—current study compared to recent literature

Paper	Total % Incidence of RH (n)	% Incidence in NVD (n)	% Incidence in Vacuum Delivery (n)	% Incidence in Forceps Delivery (n)	% Incidence in C/S (n)
Current	34.0 (18)	30.4 (7)	77.8 (7)	30.3 (3)	8.3 (1)
Emerson 2001[2]	34 (50)	33 (40)	75 (9)	0	7 (1)
Williams 1993[6]	32	25	46	22	N/A
Egge 1981[7]	37	41	50	16	N/A

RH: retinal hemorrhages; *NVD:* normal vaginal delivery; *C/S:* cesarean section.

first and for the three deliveries by forceps two had been attempted previously by vacuum delivery. Although Whitby et al did not find subdural hemorrhages in any child delivered by forceps alone, they did find hemorrhages in five children delivered by forceps following a failed vacuum delivery. Ophthalmoscopy was not performed in the Whitby study, and we cannot speculate about the incidence of retinal hemorrhages in the nine babies who had subdural hemorrhage, but it is interesting to note the similarities in incidence in relation to mode of delivery. Previous authors[10] have speculated on the coexistence of cerebral and retinal hemorrhage following birth, and the potential for subtle sequelae.

In general there is agreement in the literature that birth-related retinal hemorrhages resolve quickly[1,11] and their significance in the differential diagnosis of retinal hemorrhage due to nonaccidental injury has been discussed.[2,12] Emerson et al[2] stated that intraretinal hemor-

rhage seen at 1 month of age is "not likely related to birth." We have two subjects in this cohort whose intraretinal hemorrhages were still present at 31 and 58 days, respectively. Although this represents only a small number (11%) of our subjects with retinal hemorrhage (and only 3.8% of our total cohort), this etiology must not be forgotten when considering the differential diagnosis of non-accidental injury. It must be noted, however, that these were residual discrete hemorrhages; all extensive confluent hemorrhages had resolved by 9 to 17 days.

Forbes et al[12] stated that birth-related hemorrhages are of "small size and number." While those hemorrhages of long duration, in this series, were not great in number, those seen in the first few days of life were numerous and often 1 disk diameter or larger. This is an important fact to remember when making a differential diagnosis. Other clinical signs indicating cerebral injury will obviously arouse suspicion when found in conjunction with retinal hemorrhage, but isolated hemorrhages should be considered carefully.

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