Does Valsalva Retinopathy Occur in Infants? An Initial Investigation in Infants With Vomiting Caused by Pyloric Stenosis

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ABSTRACT. *Objective.* **Retinal hemorrhages (RHs) are 1 manifestation of child abuse, and although they often are considered to be diagnostic of abuse in a young child, there are other potential causes. RHs have been described in association with valsalva maneuver, such as forceful vomiting or coughing. Our aim was to describe the incidence of RH in infants with vomiting caused by pyloric stenosis.**

Methods. **A prospective, descriptive study was conducted of infants who underwent pyloromyotomy for hypertrophic pyloric stenosis (HPS). Dilated retinal examinations were performed, and the findings were documented.**

Results. **A total of 100 infants with HPS were evaluated. Eighty-four infants were male, 92 were white, and 21 had a family history of pyloric stenosis. Thirty-seven examinations were performed in the operating room. Eighteen examinations were confirmed by a second investigator, and 3 children had dilated eye examinations documented independently by a pediatric ophthalmologist. No RHs were identified (0 of 100; 95% confidence interval: 0%–3%). One patient had facial petechiae, and 2 had subconjunctival hemorrhage. Electrolyte levels were abnormal in 63 patients. In 89 cases, the emesis was described as projectile. Patients varied in the number of episodes of emesis, with 30% of patients having >100 episodes of emesis before diagnosis. One patient had a respiratory arrest associated with vomiting in the emergency department and required bag-valve mask ventilation.**

Conclusions. **No RHs were identified in 100 infants with vomiting caused by HPS. These results suggest that RHs do not result from forceful vomiting in infants.** *Pediatrics* **2004;113:1658–1661;** ***vomiting, retinal hemorrhages, abusive head trauma, pyloric stenosis.***

ABBREVIATIONS. RH, retinal hemorrhage; AHT, abusive head trauma; HPS, hypertrophic pyloric stenosis; CI, confidence interval.

Child abuse is a serious and growing problem in the United States and worldwide. Each year, >2000 children are killed, 18 000 are permanently disabled, and 150 000 are seriously injured in the United States as a result of abuse and neglect.[1] The majority of fatal injuries occur in the youngest children, with nearly half of all abuse-related deaths occurring in those <1 year old.[2] These statistics reflect only those cases in which maltreatment was actually identified and therefore most likely underestimate the true incidence of injuries and deaths resulting from abusive trauma.

Retinal hemorrhages (RHs) are 1 potential manifestation of child abuse, occurring in up to one quarter of all abused children and 80% or more of infants who receive a diagnosis of shaken infant syndrome.[3–5] Although considered by some to be pathognomonic for child abuse in a child <3 years old, there are numerous potential causes of RH, including birth trauma, infection, bleeding disorders, carbon monoxide poisoning, glutaric aciduria, and intracranial hemorrhage (Terson's syndrome).[6] History, physical examination, and laboratory evaluation easily exclude some of these causes. In addition, with the exception of birth, these alternative causes rarely cause RH. One well-described cause of RH in adults and adolescents is valsalva retinopathy, associated with preretinal or superficial intraretinal hemorrhages as a result of sudden, rapid rises in intra-abdominal and intrathoracic pressure that can be seen with coughing, vomiting, and weight lifting.[7,8] A review of the literature did not identify any reports documenting the occurrence of retinal hemorrhages as a result of vomiting in infants or small children.

Young children with head injuries frequently present with vomiting. A study by Jenny et al[9] found that vomiting is one of the most common presenting symptoms in cases of missed abusive head trauma (AHT). Because RHs are present in a significant proportion of infants with AHT, their presence or absence could possibly be used to help differentiate vomiting caused by abusive injuries from vomiting caused by other causes and therefore potentially decrease the number of missed cases of abuse.

Hypertrophic pyloric stenosis (HPS) is a condition seen exclusively in infants, usually between 3 and 6 weeks old. Infants often present with repeated episodes of forceful emesis before diagnosis. Because of the association with vomiting, our ability to confirm hypertrophy of the pylorus as the cause of the emesis, and the age of presentation, infants with HPS are ideal candidates in whom to investigate the incidence of RH in children with vomiting not resulting from abuse.

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We began this investigation with the hypothesis that valsalva retinopathy does not occur in infants and young children. In theory, younger children and infants should be able to generate less intrathoracic and intra-abdominal pressure and therefore be less likely to rupture the retinal capillaries. In addition, better vascular integrity in infants versus adults, as evidenced by the lack of occurrence of diabetic, hypertensive, or sickle hemorrhagic retinopathy in this age group, should be protective. This study is the first to investigate the possible association between forceful vomiting and RH in infants.

METHODS

This study was approved by the Institutional Review Board of the Children's Hospital of Pittsburgh. All infants who received a diagnosis of HPS after March 2000 were eligible for study. The diagnosis was made before surgery by 1) history and physical examination alone when a palpable "olive" was present, 2) abdominal ultrasound documenting hypertrophy of the pylorus, and/or 3) upper gastrointestinal series documenting narrowing of the barium column (string sign). In all cases, diagnosis was confirmed by direct visualization of the thickened pylorus at the time of surgery.[10] Infants were excluded when they had physical examination findings suggestive of abuse (ie, bruises), a known history of abuse, or a history of retinal abnormality or eye surgery.

Once a patient received a diagnosis of HPS, a study investigator obtained informed consent preoperatively and performed a physical examination. A detailed history was obtained to document the duration, frequency, quantity, and forcefulness of emesis and the presence, absence, and severity of symptoms of dehydration (urine output, lethargy, etc). Medical history, including a detailed birth history (vaginal or cesarean section, breech vs cephalad, induced vs spontaneous) and family history, was recorded. Findings on physical examination, such as signs of dehydration, facial petechiae, or subconjunctival hemorrhages, were documented. Results of any laboratory and radiologic studies were recorded. Patients then underwent the standard preoperative evaluation and management for patients with HPS, followed by general anesthesia and surgical repair.

Whenever possible, the dilated funduscopic examination was performed in the operating room while the patient was under general anesthesia; when this was not possible, the examination was performed as soon as possible after surgery. For examinations that were performed in the operating room, 2 drops of 0.5% tropicamide solution were instilled into each eye at the beginning of the surgical procedure.[11–14] A study investigator then performed direct ophthalmoscopy at the end of the surgical procedure while the patient was still under general anesthesia. Examinations were confirmed independently by a second investigator whenever possible (at least 10% of cases). Emergence from anesthesia and postoperative care then proceeded in the standard manner. Examinations performed after surgery were performed in the recovery room or as soon as possible on the ward. Two drops of 0.5% Tropicamide were instilled into each eye, and direct ophthalmoscopy was performed 20 to 30 minutes later.

All demographic and clinical data are reported as means or proportions. Because our hypothesis was that RHs do not occur in this population, we expected the incidence to be 0 (0 of 100). We applied Hanley's "rule of 3" in determining our desired sample size, such that if we examined 100 patients and found no RH, then the 95% confidence interval (CI) would be from 0% to 3%.[15]

RESULTS

One hundred patients with HPS were enrolled in the study from March 2000 through October 2002; an additional 12 patients were approached but declined enrollment. There were no significant differences in race, gender, severity of illness, or age at diagnosis between those who consented to participate in the study and those who did not. Although no patient met the study exclusion criteria, 1 patient who initially was enrolled in the study after a "positive" pyloric ultrasound but later was found to have a normal pylorus at the time of surgery was withdrawn from the study. Of the 100 study patients, 84 were male and 16 were female; 92 were white, 3 were black, and 5 were of mixed race. Family history was positive for HPS in 21% of patients; of those with a positive family history, 13 patients had 1, 6 patients had 2, 1 patient had 3, and 1 patient had multiple relatives with HPS. Patients ranged in age from 9 to 136 days old, with a mean age of 39 days and a median age of 36.5 days. The duration of emesis before diagnosis ranged from 1 to 120 days, with a mean and median duration of 15 and 9.5 days, respectively. Episodes of emesis were described as "projectile" in 89% of patients. The number of episodes of emesis before presentation ranged from 4 to >100, as shown in Fig 1. Diagnosis of HPS was made by history and examination alone in 14% of patients, by ultrasound in 70%, by upper gastrointestinal series in 9%, and by both ultrasound and upper gastrointestinal series in 7%.

Physical examination was normal in 73% of patients, whereas 25% of patients had examination findings consistent with significant dehydration (wasted appearance, sunken eyes and/or fontanel) and 3% of patients had either facial petechiae (1 patient, also with wasting) or subconjunctival hemorrhage (2 patients). Electrolyte abnormalities were present in 63% of patients, with the bicarbonate level being the most commonly abnormal value (63%). Bicarbonate levels ranged from 16 to 52, with a mean level of 28. Potassium levels were abnormal in 9% of patients, and sodium levels were abnormally low (<135 mEq/dL) in 17%. One patient had an episode of emesis in the emergency department, which resulted in laryngospasm, cyanosis, and respiratory arrest; this patient required bag-valve mask ventilation. No patient had hypo- or hypertension or other hemodynamic abnormalities.

Dilated eye examinations were completed in all 100 patients. Thirty-seven percent of the examinations were performed in the operating room with the patient under general anesthesia, with 4 (10.8%) of 37 confirmed in the operating room by a second investigator. Adequate pupil dilation and fundus visualization was documented in all 37 cases. Sixty-three percent of the examinations were performed outside the operating room, with 14 (22%) of 63 confirmed by a second investigator. Two of these patients required

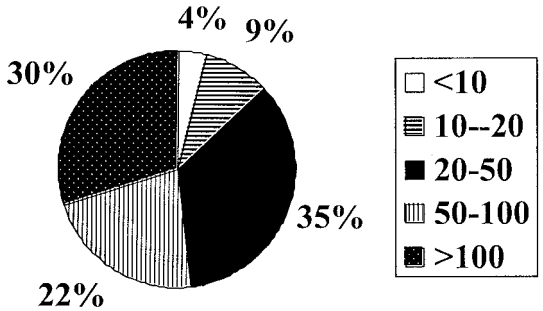

Fig 1. Frequency of emesis.

a second application of mydriatic to obtain adequate dilation, and 2 patients were documented to have a limited visualization of 1 fundus. Neither of the 2 patients with limited examination had examination or laboratory abnormalities. Three of the patients who were examined outside the operating room by a single investigator had independent examinations performed by a pediatric ophthalmologist for reasons unrelated to the study; their examinations agreed with the study investigator's findings in all 3 cases. No RHs were found on dilated funduscopic examination in any of the 100 patients studied (0 of 100; 95% CI: 0%–3%).

DISCUSSION

RH resulting from changes in venous and arterial pressures have been described as a result of valsalva maneuver, traumatic chest and/or abdominal compression (Purtscher's retinopathy), and traumatic asphyxia.[7,16,17] In each of these entities, preretinal hemorrhages (and, less common, intra- and subretinal hemorrhages) are thought be caused by the rupture of superficial retinal capillaries as a result of increased venous pressure, increased arterial pressure, or a combination of both. Hemorrhages are almost exclusively limited to the posterior pole of the retina and tend to resolve without sequelae. Although multiple case reports and series have been published describing this phenomenon in adolescents and adults and a few case reports have described RH in association with laryngospasm and suffocation in children, we were unable to find any literature documenting cases of valsalva retinopathy caused by vomiting in infants or young children.[18,19] RHs in children <3 years old, outside of the immediate neonatal period, are most commonly ascribed to child abuse.

We chose our patient population for several reasons. First, by limiting our study population to infants who were proved to have HPS, we sought to ensure that we studied only infants with a clearly defined pathologic reason for their vomiting. By combining this confirmed diagnosis with a careful history and examination, our goal was to eliminate the possibility that patients with AHT would confound the results of our study.[20] Second, the majority of AHT occurs in infants and younger children, and younger infants are more likely to die as a result of AHT. The majority of patients with HPS are diagnosed between 3 and 6 weeks old, and all of our patients were <5 months old. Finally, by using a surgically treated condition such as HPS, we could perform at least some of the dilated eye examinations while the infant was under general anesthesia, thus improving the quality of our evaluations.

One limitation of our study is that we did not have an ophthalmologist perform the dilated eye examinations, and we used only direct ophthalmoscopy. An ophthalmologist was involved in the initial design of this study, and it was decided that ophthalmology would confirm any abnormal or concerning findings. All of the descriptions of valsalva retinopathy indicate that the hemorrhages are almost exclusively limited to the posterior pole, and patients with peripheral hemorrhages had posterior pole involvement in all of the reviews that we found. RH in this location should be well visualized with direct ophthalmoscopy. This is in contrast to the hemorrhages seen with AHT, which tend to involve all layers of the retina and often extend peripherally to the ora serrata, requiring indirect ophthalmoscopy for complete visualization. All of the investigators who performed examinations (R.P., R.B., M.P., and S.H.) were also members of the hospital's Child Protection Team and routinely perform dilated eye examinations in conjunction with an ophthalmologist on known and suspected abuse cases; 3 of the investigators (S.H., M.P., and R.P.) are also pediatric emergency medicine physicians and therefore perform dilated eye examinations to screen for RHs, papilledema, retinal detachments, and other abnormalities on a routine basis. In the 3 cases in which an ophthalmologist evaluated patients in this study, their examination agreed with that of the study investigator. A recent study by Monrad et al[21] documented that nonophthalmologist examinations documented hemorrhages in 28 (87%) of 32 patients with RHs as a result of shaken infant syndrome; there were no false-positive examinations. The level of training and experience of the nonophthalmologists and proportion of dilated versus nondilated examinations were not discussed in this article. A previous study by Kivlin et al[22] documented 71% accuracy of nonophthalmologists in detecting RHs in children with AHT, and there was 1 false-positive examination by the nonophthalmologist. This study also did not document the use of mydriatics or the level of training or experience of the examiners. We sought to ensure optimal conditions for screening ophthalmologic examination in our study by ensuring adequate pupil dilation, performing examinations under general anesthesia or during postoperative sedation whenever possible, and having all examinations performed by attending-level physicians with experience in performing such evaluations. We also had a second examiner confirm the examination findings in 21% of cases.

By studying only patients with HPS, we limited the age range of our patients to young infants. It is possible that older infants and children with conditions associated with forceful and repetitive cough and/or vomiting (pertussis, gastroesophageal reflux, gastrointestinal obstruction) may generate greater pressures and therefore be more likely to develop valsalva retinopathy. Future investigations are needed to evaluate a broader age range and varied causes to address better whether infants and children can develop RHs as a result of forceful cough or vomiting.

CONCLUSION

In this initial investigation, we found that 0 of 100 infants with vomiting caused by pyloric stenosis had RHs. This finding supports our hypothesis that valsalva retinopathy does not occur in infants.

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"Treatment of asymptomatic abnormal vaginal flora and bacterial vaginosis with oral clindamycin early in the second trimester significantly reduces the rate of late miscarriage and spontaneous preterm birth in a general obstetric population."

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