NONOPHTHALMOLOGIST ACCURACY IN DIAGNOSING RETINAL HEMORRHAGES IN THE SHAKEN BABY SYNDROME

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Nonophthalmologists did not attempt to (36%) or were "unable to" (19%) examine the fundus in 72 children with shaken baby syndrome. When the retina was examined, nonophthalmologists were accurate in recognizing the absence or presence of retinal hemorrhage in 87%. However, false-negative examinations occurred in 13%. Ophthalmology consultation should be an integral part of the evaluation of children with suspected abuse. (*J Pediatr 2003;142:431-4*)

The most common ocular findings in shaken baby syndrome (SBS) are retinal hemorrhages (RHs),[1-4] recognition of which requires retinal examination. When the child is hospitalized, fundus examination is usually first performed by nonophthalmologists, such as emergency department physicians, pediatricians, or neurosurgeons, before a formal ophthalmology consultation takes place. Differences in the eye findings between nonophthalmologists and ophthalmologists may lead to confusion and misunderstanding, especially in the criminal courtroom process. Our study compares the accuracy of results of fundus examinations by nonophthalmologists with those done by ophthalmologists.

METHODS

We reviewed the charts of all patients diagnosed with SBS and examined by the Ophthalmology Service at The Hospital for Sick Children, Toronto, from January 1993 to December 1999. Diagnosis required at least two of the following: characteristic neuroradiologic abnormalities; skeletal injury; RHs; a history of child abuse that included shaking; and no adequate history to explain the injuries. We recorded and compared the results of nonophthalmologist and staff ophthalmologist fundus examinations.

RESULTS

The study group included 75 children (Figure). Records sufficient for completion of this study were available on 72 patients with an average age of 10.6 ± 10.4 months (range, 2-48 months). None of the charts had records of fundus examination done by more than one nonophthalmologist or one staff ophthalmologist. Sixty-one patients (85%) had RHs documented by the ophthalmology consultant. All patients initially presented to a service other than ophthalmology. In 14 cases (19%), the nonophthalmologist indicated that he/she attempted, but was unable, to examine the retina. In 26 children (35%), there was no documentation regarding fundus examination. In 32 (44%) patients, nonophthalmologists successfully examined the fundi and recorded their results. They correctly diagnosed the presence or absence of RHs in 28 of 32 (87%) patients: 24 had RHs. In 4 of 32 patients (13%), nonophthalmologists incorrectly documented normal retinas, whereas in fact, RHs were present (false-negatives, Table). In no case did the nonophthalmologist report hemorrhages where none existed (false-positives). None of the records written by nonophthal-

RH	Retinal hemorrhage
SBS	Shaken baby syndrome

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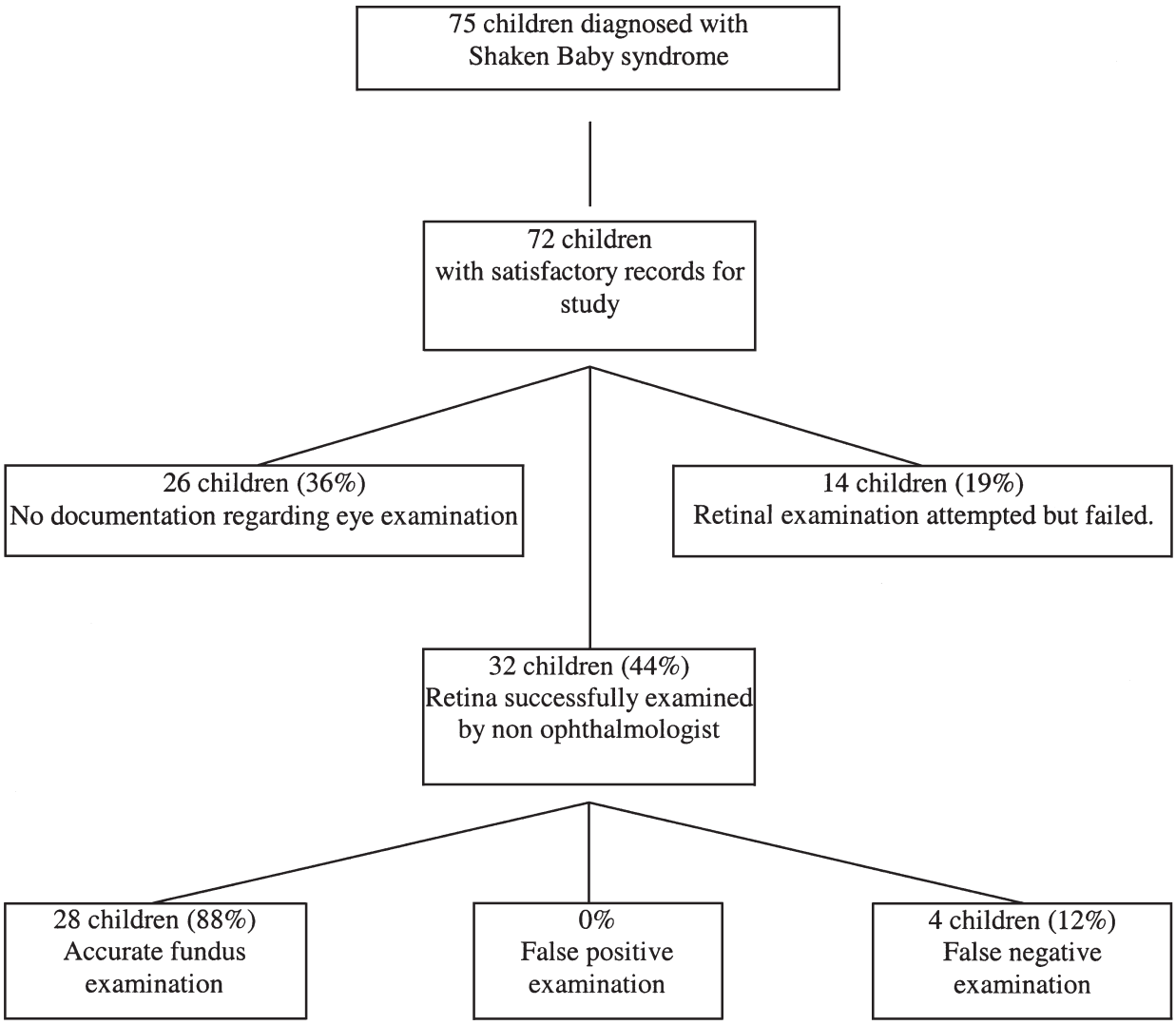

Fig 1. Fundus examination rate and accuracy by nonophthalmologists in children diagnosed with SBS.

mologists noted the type, number, or location of hemorrhages. None of the nonophthalmologists used pupil-dilating drops to facilitate retinal examination. Ophthalmologists, however, used these drops on all occasions.

The maximum interval between the nonophthalmologists' incorrect examinations and the ophthalmologic consultation was 24 hours. Nonophthalmologists successfully examined the fundus and recorded the results for 16 (16/28, 57%) patients in the pediatric intensive care unit and for the remaining 12 (12/28, 43%) in the emergency department. We were unable to determine the exact subspecialty role or level (trainee, staff) of the nonophthalmologist examiners from all charts.

DISCUSSION

Accuracy and consistency in diagnosis of retinal abnormalities is especially important in the SBS, because cases are scrutinized both medically and legally. Our study indicates that whenever a possibility of SBS arose, the Ophthalmology Service was consulted, in keeping with current recommendations.[1]

Nonophthalmologists able to perform a retinal examination were fairly accurate (87%) in noting the presence or absence of RHs. However, in 4 cases false-negative results were documented, similar to the rate observed by Kivlin et al.[5]

The false diagnosis of "normal retina" may be caused by an inability to visualize the affected retina with the direct ophthalmoscope (Case 1), misinterpretation of the diffusely red appearance of nearly confluent hemorrhage as normal retina (Case 2), or suboptimal examination technique. This error may lead to a false diagnosis of accidental injury, and the ophthalmology consultation may be delayed or not requested. Moreover, delayed diagnosis of RHs may raise the possibility that the hemorrhages could have developed as a result of events occurring after admission to the hospital, although in our cases we could not identify such factors. Kivlin et al have reported cases of false-positive examinations by nonophthalmologists, which raise other concerns as well as potential

Table. False-negative nonophthalmologist retina examinations

Case	Age/Sex	Presenting symptom	Nonophthalmologist subspecialty	Nonophthalmologist examination	Ophthalmologist examination
1	4 mos/Female	Seizures	Neurosurgeon	Normal retinas "seen well"	Patch of hypopigmented spots in the mid-periphery, inferior to the disc, consistent with resolving RH
2	3 wk/Male	Drowsiness	Pediatric emergency physician	Normal retinas	Severe diffuse intra-RHs involving the entire retina in both eyes with retinoschisis (separation of retinal layers) superiotemporally, in one eye
3	11 mos/Female	Alleged fall, painful elbow	Pediatric emergency physician	Normal retinas	Retinoschisis in the posterior pole in one eye, with multiple areas of subhyaloid blood along the superior temporal arcades in both eyes
4	3 y/Male	Unresponsive	Neurosurgeon	Normal retinas	<10 intra-retinal flame-shaped hemorrhages in each eye confined to the posterior pole surrounding the optic nerve within 2 disc diameters, plus one pre-RH on a vascular arcade in the posterior pole of each eye

courtroom confusion.[5] Perhaps the medical record should note that the examination done by a nonophthalmologist is preliminary and its findings subject to confirmation by the Ophthalmology Service.

In most cases (40/72, 55%), fundus examination was either attempted unsuccessfully (25/72, 35%) or not attempted at all (14/72, 26%). Because we do not know if other health care professionals attempted such examinations and failed without documentation, it is possible that these rates are even higher in reality. In our opinion, these findings are troubling, in view of the importance of retinal findings in contributing to the diagnosis of child abuse. Nonophthalmologists usually perform fundus examinations with a direct ophthalmoscope. Although this instrument does not allow the examiner to visualize the far periphery of the retina, it provides an excellent view of the optic discs, maculae, and posterior retina.[6] Yet even in the most experienced hands, this examination can be difficult, particularly in children who are non-cooperative, especially when the pupil is not dilated. We did not find written orders by nonophthalmologists for pupil dilating drops in any of the charts. It may be that some nonophthalmologists are not aware of the preferred agents and doses, or feel that dilating drops are not necessary because ophthalmologic consultation is pending. Others desire to preserve pupil reactivity in neurologically unstable children. Although cyclopentolate 1% is active for as long as 24 hours, tropicamide 1% or phenylephrine 2.5% are active for only 5 to 7 hours.[7] Other options include dilating one pupil at a time or allowing the ophthalmologist to first attempt small pupil examination techniques and reserving pharmacological dilation for situations where these techniques fail.

In conclusion, we find that in most cases of suspected SBS, nonophthalmologists did not attempt or did not succeed in visualizing the retina. Although they were generally successful in correctly diagnosing the presence or absence of RHs when they did complete the eye examination, important forensic information regarding the type, location, and number of the hemorrhages was always missing. Our finding of false-negative findings serves to document that misdiagnosis does indeed occur, and underscores the need to enhance the nonophthalmologists' ability to perform this examination, improve documentation of preliminary findings, and obtain ophthalmologic consultation in every case of suspected child abuse.

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50 Years Ago in *The Journal of Pediatrics*

SERUM CALCIUM AND INORGANIC PHOSPHATE IN THE NEWBORN INFANT, AND THEIR RELATIONS TO DIFFERENT FEEDINGS

Graham G, Barness L, György P. J Pediatr 1953;42:401-8

These three "pioneers" in pediatric nutrition and metabolism wrote this article at a time when the etiology of newborn tetany was uncertain. They documented that infants given cow's milk-derived "evaporated" formula had higher serum phosphate concentrations, especially in the third to fifth day of life, when compared with breast-fed infants. Although they did not demonstrate significant hypocalcemia related to hyperphosphatemia, these data were part of the accumulating data that "evaporated" formulas were a main reason for hypocalcemia and tetany at one week of age, related to markedly high phosphate intake.

Since then, the phosphate content in modern cow's milk-derived formulas has been reduced, and tetany related to cow's milk formula seemed to have disappeared. However, reports in the last two decades indicate otherwise. In fact, because of a basic misassumption, term infants who present with tetany in the emergency department are often initially labeled as having "seizure disorders," and only after perceptive investigation, are they correctly diagnosed as having hypocalcemia related to hyperphosphatemia, from modern cow's milk formulas. Elevated serum parathyroid hormone concentrations occur in such infants (vs breast-fed infants), are positively related to phosphate concentrations, and are inversely related to serum calcium concentrations. These infants thus have classic phosphate-induced hypocalcemia with secondary hyperparathyroidism. (Am J Dis Child 1985;139:664)

A prospective study of healthy formula-fed infants with varying Ca/P ratios demonstrated that serum phosphate concentrations are higher and ionized calcium lower in formula-fed infants versus breast-fed infants. Parathyroid hormone concentration was significantly increased and correlated with phosphate intake, confirming that modern-day formulas still have the potential for induction of hypocalcemia and tetany. (Am J Dis Child 1991;145:941)

In the United Kingdom, infantile hypocalcemic tetany is related also to vitamin D status of the mother and infant, and is reduced when vitamin D status is normalized by supplemental vitamin D intake in mothers. (BMJ 1980;231)

In conclusion, although the incidence of infantile hypocalcemic tetany from cow's milk formulas has been markedly reduced, it appears that the condition still exists, and emergency department pediatricians need to be aware for its appropriate diagnosis and management.

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