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Original Contributions

PREVALENCE OF RETINAL HEMORRHAGES IN INFANTS PRESENTING WITH ISOLATED LONG BONE FRACTURES AND EVALUATION FOR ABUSE

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☐ **Abstract—Background: Fractures are a frequent reason for emergency department visits and evaluation for abusive head trauma is an associated concern in infants. Recent guidelines have suggested that retinal examination may not be necessary in the absence of intracranial injury, but there is a lack of empirical evidence in infants < 1 year of age. Objective: Our aim was to evaluate the prevalence of retinal hemorrhages in infants with isolated long bone fractures. Methods: Retrospective chart review of infants < 1 year of age who presented to an urban, tertiary care pediatric hospital between January 2004 and April 2014 with the diagnosis of an acute long bone fracture or retinal hemorrhages. Patients were excluded for head injury, altered mental status, injury mechanism of motor vehicle accident, multiple fractures or injuries outside the fracture area. Patients were identified through trauma registry data and International Classification of Diseases codes. Results: One hundred and forty-six patients had isolated long bone fractures, of which 68 patients did not undergo a retinal examination and 78 patients had dilated eye examinations, with no patients identified as having retinal hemorrhages. There were 46 patients identified with retinal hemorrhages concerning for abuse. No patients with retinal hemorrhages had isolated long bone fractures. Conclusions: In infants < 1 year of age presenting with isolated long bone fractures, a dilated eye examination to evaluate for retinal hemorrhages is not likely to yield additional information. Our results support recent studies that a subset of children and infants may not require dilated eye examinations in the evaluation of possible abuse.**

☐ **Keywords—retinal hemorrhages; fracture; child abuse; infant; child**

INTRODUCTION

According to the U.S. Department of Health and Human Services, approximately 2% of children < 1 year of age were victims of abuse (1). In children < 12 months of age, 25% of all fractures result from abuse (2). Acute fractures are a frequent reason for emergency department (ED) visits and constitute 10%–25% of all pediatric injuries (3). Determining whether the injury is inflicted vs. accidental is essential to preventing repetitive abusive injuries, particularly in nonverbal patients. When a nonambulatory or young patient presents with an acute fracture, evaluation for associated abusive head trauma (AHT) is a critical concern, as head trauma is the primary cause of mortality in abused children (4,5). Current recommendations state young and nonambulatory patients presenting with a fracture and concern for abuse should be evaluated utilizing a detailed history, physical examination, skeletal survey, and a computed

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tomography (CT) of the head (6,7). Guidance from the American Academy of Pediatrics has recommended a dilated eye examination by an ophthalmologist with pediatric experience to evaluate for retinal hemorrhages (RHs) in any infant or young child who is a suspected victim of physical abuse (8). Only the most recent guidelines have suggested that retinal examination may not be necessary in the absence of intracranial injury, but there is a lack of empirical evidence in infants < 1 year of age in isolation from older children (9).

Evaluation by an ophthalmologist with pediatric experience often requires transfer of patients to tertiary care centers. Even when an ophthalmologist with pediatric experience is accessible, retinal examination increases patient and familial stress, expends more resources, and increases costs. Recent studies that included children up to 2 years of age and older have shown that dilated eye examinations may not be required in all children evaluated for abuse (10–13). The purpose of this study was to determine the prevalence of RH in patients < 1 year of age with a long bone fracture and no other identified signs of abuse. We also sought to identify infants at low risk for RH who may not require a dilated eye examination on a routine basis.

MATERIALS AND METHODS

This study is a retrospective chart review of children < 1 year of age who were evaluated in the ED or inpatient unit at a tertiary care children's hospital for either an isolated acute long bone fracture or retinal hemorrhages from January 2004 through April 2014. The study was approved by the Institutional Review Board at the academic center. Exclusion criteria were known head injury, altered mental status, the injury was sustained in a motor vehicle accident, multiple fractures not of a single bone group (radius/ulna or tibia/fibula), and signs of injury away from the fracture site, including bruising, lacerations, petechia, hematomas, or areas of swelling.

Patients were identified through the trauma registry and billing office by querying for any fracture using International Classification of Diseases (ICD) codes 800.00–829.1. Patient data were collected from paper records (January 2004 through April 2010) and electronic medical records (April 2010 through April 2014). For those patients included in the final analysis, collected data included age, sex, presence of and description of retinal hemorrhages, location and type of fracture, and whether a skeletal survey or CT of the head was performed. Information on race was not consistently available and was not recorded. All charts were reviewed by a board-certified pediatrician. To ensure reliability of the data, patient information was subsequently reviewed by a board-certified child abuse pediatrician or a board-certified pediatric emergency physician. To verify that no patients with RH were missed, an additional search was performed using ICD code 362.81 for RH. At our institution, RH data were also included in the trauma registry beginning in 2008. Charts of patients identified as having RH were reviewed to ensure no patients were missed by fracture ICD codes and trauma registry database information. Presenting chief complaint and initial presentation to the ED were also identified for those with RH. Demographic variables for patients undergoing a retinal examination vs. those who did not were compared using the Mann-Whitney U test, χ^2 test, or Fisher's exact test, as indicated. A p value < 0.05 was considered statistically significant. Analyses were performed using SPSS software, version 21.0 (IBM Corporation, Armonk, NY).

RESULTS

A total of 810 patients with long bone fractures were identified, of which 146 patients had isolated long bone fractures (Figure 1). Of those with isolated long bone fractures, 78 patients underwent dilated eye examinations and 68 patients did not undergo a retinal examination. Of the 78 patients with isolated long bone fractures and retinal examinations, none had retinal hemorrhages. Subanalysis of this group showed that all of the patients had skeletal surveys and 53 had a CT of the head performed. Of the 68 patients without retinal examinations 53 had skeletal surveys and 13 had a CT of the head performed. Those

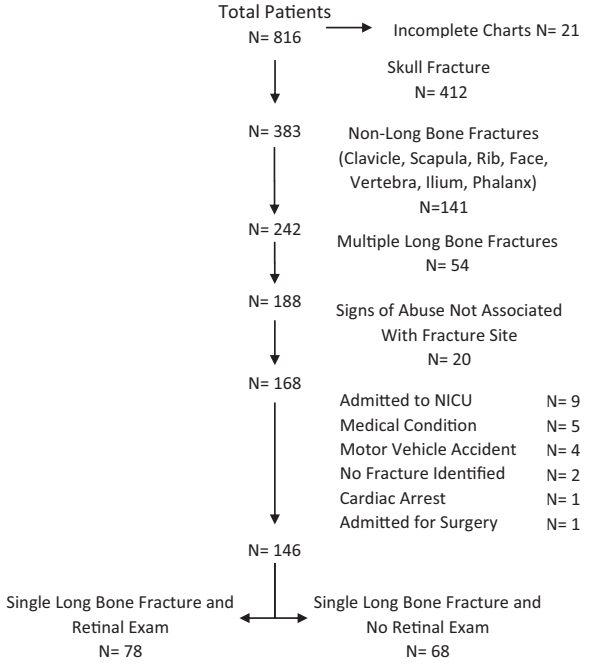

Figure 1. Study flow diagram. NICU = neonatal intensive care unit.

who underwent retinal examination were younger than those who did not undergo retinal examination (median age 5.0 months; interquartile range [IQR], 1.8–7.0 months vs. 8.0 months; IQR, 5.3–10.0 months, respectively; $p < 0.01$) and were less likely to have a tibia/fibula fracture ($p < 0.01$). We did not find an association between undergoing a retinal examination and sex, fractures of the humerus, radius/ulna, or femur (Table 1).

The additional chart review for cases of retinal hemorrhages revealed 54 patients were identified as having retinal hemorrhages, 46 of those cases were considered by a child abuse specialist to be concerning for abuse. Of the patients concerning for abuse, 6 presented in full cardiopulmonary arrest; 36 presented with seizures, moderate to profound mental status changes, apnea, or respiratory failure. One chart was incomplete, but ICD codes indicated the presence of subdural hematoma and convulsions. None of the patients identified as having retinal hemorrhages had isolated long bone fractures. Seven patients had retinal hemorrhages that were not concerning for abuse. Five patients were admitted to the neonatal intensive care unit or newborn nursery at birth and were believed to have RHs related to birth trauma. Two patients were evaluated by child abuse specialists, who determined that the retinal hemorrhages were not likely due to abuse. One of the patients received accidental trauma in a house fire and the other patient had increasing head circumference caused by chronic subdural hemorrhages most likely from a traumatic birth.

DISCUSSION

This retrospective study supports the assertion of recent literature that retinal examination is not likely to be beneficial as a screening tool for nonaccidental trauma in infants with isolated long bone fractures.

One of the main concerns in the evaluation of children for suspected AHT is that many publications have shown RHs are present in 51%–85% of children with AHT (14–21). Due to this high rate of positive retinal examinations in children with AHT, retinal examinations have been performed in children who are being evaluated for abuse, even if they show no signs of traumatic brain injury (TBI). A few recent studies have introduced and reinforced the concept that in the absence of signs of TBI, retinal hemorrhages are rare and retinal examination may not be warranted (10–13).

This study contributes to this growing body of literature by demonstrating in a population < 1 year of age presenting with isolated long bone fractures, retinal hemorrhages were not present; suggesting dilated retinal examinations may not be required. In the prior studies suggesting dilated retinal examinations may not be required in the absence of TBI, age limits of inclusion were 10 years, 58 months, and 2 years (9,10,12,13). In this study, all patients who had a retinal examination performed were < 1 year of age and had a median age of 5.0 months (IQR 1.8–7.0 months). This younger age group is similar to the age group at greatest risk for AHT and is more likely to have abnormal retinal examination findings with AHT (18).

Limitations

This study has several limitations. It is a retrospective chart review with the usual associated limitations, including outcome assessment, misclassification, selection biases, and information biases. To mitigate against this, we employed a broad search strategy utilizing multiple ICD codes and redundant local trauma registry data. The study is also limited in that it was performed at a single institution. Of note, only 78 (53%) patients < 1 year of age with isolated long bone fractures at our institution underwent a retinal examination. Older infants were less likely to have had a retinal examination performed (Table 1). One possible explanation for this finding is that, among older infants, the plausibility of accidental injury increased, and the concern for abuse, therefore, was lower, but it is possible these older children had retinal hemorrhages that were not identified (22–26). In addition, this study did not collect data on whether the treating providers determined the fractures to be from

Table 1. Demographic Characteristics

	Single Long Bone Fracture and Retinal Exam	Single Long Bone Fracture and No Retinal Exam (n = 68)	*p* Value
Male, n (%)	44 (56.4)	31 (45.6)	0.19
Age, months, median (IQR)	5.0 (1.8–7.0)	8.0 (5.3–10.0)	<0.01
Fracture site, n (%)			
Humerus	22 (28.2)	11 (16.2)	0.08
Radius/ulna	3 (3.8)	7 (10.3)	0.19
Femur	46 (59.0)	32 (47.1)	0.15
Tibia/fibula	7 (9.0)	18 (26.5)	<0.01

IQR = interquartile range.

abuse. The likelihood that many of the children were abused was high, as it has been reported 35–75% of femur fractures, 54–100% of humerus fractures, and 40–96% of tibia/fibula fractures are concerning for abuse in children < 12 to 18 months (25–32). Finally, despite a 10-year time period, the number of subjects in the final analysis is relatively small. Based on our data, an estimate of the 95% confidence interval suggests that the true incidence of RHs in infants with isolated long bone fractures is < 4% (33). A larger study is needed to confirm our findings.

CONCLUSIONS

We found that in children < 1 year of age presenting with isolated long bone fractures and who underwent a dilated eye examination, no retinal hemorrhages were identified. Despite its limitations, the results of this study add further validity to the growing body of literature that retinal examinations are a poor screening tool in patients with isolated long bone fractures in the evaluation of nonaccidental trauma, and with careful selection, a subset of children do not require dilated eye examinations in the evaluation of abuse.

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ARTICLE SUMMARY

1. Why is this topic important?

Infants who present with an acute fracture require evaluation for associated abusive head trauma, which is the primary cause of mortality in abused children. Recent studies have suggested that retinal examination may not be necessary in certain subsets of children being evaluated for abusive head trauma, but there are currently no studies that have evaluated infants < 1 year of age in isolation from older age groups.

2. What does this study attempt to show?

The purpose of this study was to determine the prevalence of retinal hemorrhages in patients < 1 year of age with an isolated long bone fracture. This study also attempts to identify infants at low risk for retinal hemorrhages who may not require a dilated eye examination on a routine basis.

3. What are the key findings?

Of the 78 patients with isolated long bone fractures and retinal examinations, none had retinal hemorrhages. No patients identified as having retinal hemorrhages concerning for abuse had isolated long bone fractures.

4. How is patient care impacted?

This study identifies infants at low risk for retinal hemorrhages who may not require a dilated eye examination on a routine basis. Implementation of this study's findings decreases the need for ophthalmology evaluations, which will reduce transfers to tertiary care centers, resource utilization, and medical costs.