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Original Research

Pediatric Fingertip Injuries: Association With Child Abuse

Christopher S. Klifto, MD, [*] Jessica A. Lavery, MS, [†] Heather T. Gold, PhD, [†,‡] Michael T. Milone, MD, [†] Raj Karia, MPH, [†] Vincent Palusci, MD, [§] Alice Chu, MD [‖]

[*] Department of Orthopaedics, Duke University Medical Center, Durham, NC
[†] Department of Orthopaedics, Hospital for Joint Diseases, NYU School of Medicine, New York, NY
[‡] Department of Population Health, NYU School of Medicine, New York, NY
[§] Department of Pediatrics, NYU School of Medicine, New York, NY
[‖] Department of Orthopaedics, Rutgers- New Jersey Medical School, Newark, NJ

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Purpose: Pediatric fingertip injuries are most commonly reported in the setting of an accidental occurrence. The purpose of this study was to determine whether there is an association of child abuse and neglect with pediatric fingertip injuries.

Methods: The New York Statewide Planning and Research Cooperative System (2004 to 2013) administrative database was used to identify children aged 0 to 12 years who presented in the inpatient or outpatient (emergency department or ambulatory surgery) setting. International Classification of Diseases, Ninth Revision diagnosis codes were used to identify fingertip injuries (amputation, avulsion, or crushed finger) and abuse. Cohort demographics of children presenting with fingertip injuries were described. We analyzed the association between fingertip injuries and child abuse using multivariable logistic regression, with variables for insurance status, race, ethnicity, sex, and behavioral risks including depression, attention-deficit hyperactivity disorder, aggressive behavior, and autism.

Results: Of the 4,870,299 children aged 0 to 12 years in the cohort, 79,108 patients (1.62%) during the study period (2004 to 2013) presented with fingertip injuries. Of those with a fingertip injury, 0.27% (n = 216) presented either at that visit or in other visits with a code for child abuse, compared with 0.22% of pediatric patients without a fingertip injury (n = 10,483). In an adjusted analysis, the odds of a fingertip injury were 23% higher (odds ratio [OR] = 1.23; 95% confidence interval [CI], 1.07–1.41) for children who had been abused, compared with those who had not. Patients were more likely to present with fingertip injuries if they had ever had Medicaid insurance (OR = 1.40; 95% CI, 1.37–1.42) or had a behavioral risk factor (OR = 1.35; 95% CI, 1.30–1.40).

Conclusions: Patients presenting with abuse are significantly more likely to have fingertip injuries during childhood compared with those without recorded abuse, which suggests that these injuries may be ones of abuse or neglect. Medicaid insurance, white race, and behavioral diagnoses of depression, attention-deficit hyperactivity disorder, aggressive behavior, and autism were also associated with increased odds of presenting with fingertip injuries.

Type of study/level of evidence: Prognostic III.

Fingertip injuries, including amputations, avulsions, and crush injuries, represent approximately two-thirds of pediatric hand injuries[1] and pediatric fingertip amputations account for 54% of all pediatric amputations.[2] In a 5-year review of national data, Borne et al[2] reported that digital amputations occur most commonly in 1- to 3-year-olds, and the "caught-between" mechanism accounts for most cases (39%) in all children aged younger than 11 years. It is suspected that many injuries are related to doors.[3] The incidence of pediatric door-related injuries rose between 1999 and 2008 to an average of one injury every 4 minutes and a subsequent 6% amputation rate.[4] Although previous work described practical prevention tactics ranging from pinch-free rubber seals to

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Corresponding author: Christopher S. Klifto, MD, Department of Orthopaedics, Duke University Medical Center, 810 9th Street, Apartment 336, Durham, NC 27705.
E-mail address: cklifto@gmail.com (C.S. Klifto).

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improvised doorstops using household objects (such as towels), and stressed the importance of increased parental awareness of this danger, currently there are no public health programs focused on preventing amputations arising from the "caught between door" mechanism.[2] Part of this lack of societal awareness may be connected to the belief that these injuries are considered an accidental trauma. Early identification, reporting, and intervention are needed to prevent further injury and harm.

The US Department of Health and Human Services[5] estimated that child abuse occurred in 9.4/1,000 children in 2014. Because bony injury is the second most common manifestation of child abuse, orthopedic surgeons are integral to its recognition.[6] Indeed, one-third of all abused pediatric patients are seen by orthopedists.[7] Although the most specific bony manifestations include metaphyseal corner and long bone fractures, most orthopedic findings are less specific and none are pathognomonic.[6] Nonetheless, when abuse is suspected, there is a mandate to report the suspected abuse to the appropriate authorities. Missing cases of abuse can have deadly consequences. In 1995, for instance, 1,215 children were reported to have died as a result of abuse or neglect in the United States, and 46% of fatalities from abuse occurred in children with prior contact with protective agencies.[8]

Neglect can also cause significant injury to children. By definition, neglect means failure to care for a patient properly. Neglect is often considered to be an entity separate from abuse but to result in injuries that are just as severe. Approaches to mitigating abuse and neglect can be different but of major importance to prevent future injuries to patients. Abuse requires evaluation by Child Protective Services whereas neglect does not currently require evaluation, so the distinction is important. To date, fingertip injuries are largely considered to be accidental or a result of neglect.

As with other incidents of suspected abuse, parents have provided a vague history with contradictory statements. They may delay seeking treatment, and most important, the developmental stage of the child may be inconsistent with the mechanism of injury. To our knowledge, there has been no study of the association between pediatric fingertip injures and abuse or neglect. For these reasons, we sought to investigate fingertip injuries as a potential form of child abuse, which can be used to identify potential victims better. Specifically, the purpose of this study was to use a statewide database to identify children who sustained fingertip injuries, and to report (1) demographic factors associated with fingertip injuries, and (2) associations between fingertip injuries with abuse and other demographic and behavioral risk factors.

Materials and Methods

The New York Statewide Planning and Research Cooperative System (SPARCS) (2004 to 2013) administrative database was used to identify inpatient and outpatient (emergency department and ambulatory surgery) visits for children aged 0 to 12 years. SPARCS is an all-payer claims database that captures discharge records from all facilities providing inpatient, emergency department, or ambulatory surgery services in New York State regardless of insurance status. Using an encrypted patient identifier, multiple admissions to the same patient across hospitals in New York State can be linked.

We used International Classification of Diseases, Ninth Revision (ICD-9) diagnosis codes to identify children presenting in the inpatient or outpatient setting with a crushed fingertip, fingertip avulsion, or fingertip amputation or child behavioral risk characteristics including depression, attention-deficit hyperactive disorder (ADHD), aggressive behavior, and autism (Appendix A). Demographics included age, sex, race, ethnicity, and insurance status (ie, ever having been enrolled in Medicaid). Patients with abuse (emotional, sexual, physical, neglect, shaken infant syndrome, or other/unspecified) were also identified using ICD-9 diagnosis codes (Appendix A). Moreover, ICD-9 codes specifically regarding forms of abuse and those pertaining to neglect were identified and reported. Incidence of fingertip injuries were compared among children who had a documented encounter for abuse or neglect versus children who had not, at either the same or separate encounter during the observation period.

We applied a multivariable logistic regression with the Firth's[9] penalized likelihood correction for rare events to identify factors associated with fingertip injuries, specifically the association between fingertip injuries and abuse. This analysis is used to reduce bias when the outcome is a relatively rare event, such as with fingertip injuries, and it is possible that results produced from a logistic regression could be biased.[10] The model was adjusted for age at first inpatient admission or outpatient encounter (0, 1 to 2, or 3 to 12 years), sex, race (white, black, Asian, or other/race unknown), ethnicity (Hispanic, non-Hispanic, or multiethnic/ethnicity unknown), insurance (ever enrolled in Medicaid: yes or no), and a behavioral composite of depression, ADHD, aggressive behavior, and autism. Adjusted odds ratios (OR) and 95% confidence intervals (CI) are presented. All analyses were performed using SAS System for Windows (version 9.4, SAS Institute, Cary, NC) with statistical significance set to $P < .05$.

Results

From 13,275,051 inpatient and outpatient encounters by patients aged 12 years and younger treated between 2004 and 2013 in New York State, 132 records were excluded (0.003%) because they could not be tracked over time, and an additional 276 (0.01%) owing to missing information on sex. After these exclusions, there were 13,261,460 encounters for 4,870,299 patients remaining for analysis.

A total of 79,108 children (1.6%) were identified with a fingertip injury, 76,839 of whom had one occurrence of a fingertip injury (97.2%), 2,168 had 2 (2.7%), and 101 had 3 or more visits for fingertip injuries over the study period (0.1%). There were 10,699 patients with documented child abuse or neglect in the final cohort (0.22%). Of the 79,108 children with a fingertip injury, 216 had documented abuse or neglect (0.27%); among the 4,791,191 children without a fingertip injury 10,483 had a code of abuse during age 0 to 12 years (0.22%) (Table 1).

Multivariable analysis indicated that a 23% increased likelihood of having been abused or neglected if the patient presents with a fingertip injury, compared with those who do not (OR = 1.23; 95% CI, 1.07–1.41; $P = .003$). Furthermore, significantly increased odds of presenting with a fingertip injury were associated with age 1 to 2 years (OR = 1.58; 95% CI, 1.55–1.62) and 3 to 12 years (OR = 1.56; 95% CI, 1.53–1.59) compared with less than age 1 year, white race, male sex (OR = 1.28, 95% CI, 1.26–1.30), multiethnic or unknown ethnicity (OR = 1.26; 95% CI, 1.24–1.29), ever having been enrolled in Medicaid (OR = 1.40; 95% CI, 1.37–1.42), and one or more behavioral risks (ie, depression, ADHD, aggressive behavior, or autism) (OR = 1.35; 95% CI, 1.30–1.40) (Table 2).

Discussion

This large, population-based study evaluated the association between pediatric fingertip injuries and abuse or neglect to investigate rising anecdotal suspicion. If patients with fingertip injuries are more likely to be abused during childhood, these injuries may warrant further workup, rather than the common assumption that fingertip injuries are a form of accidental trauma. To date, pediatric fingertip injuries typically are not considered an

Table 1
Characteristics Associated With Fingertip Injury Among Patients Aged < 13 y in New York State, 2004–2013 (n = 4,870,299)

Characteristics	Fingertip Injuries		
	No (n = 4,791,191), n (%)	Yes (n = 79,108), n (%)	χ^2 *P* Value
Age, y (at first visit)			
0	1,195,056 (98.85)	13,960 (1.15)	< .001
1–2	1,049,372 (98.19)	19,307 (1.81)	
≥ 3	2,546,763 (98.23)	45,841 (1.77)	
Race			
White	2,117,193 (98.07)	41,718 (1.93)	< .001
Black	980,082 (98.61)	13,783 (1.39)	
Asian	159,951 (98.99)	1,633 (1.01)	
Other/unknown	1,533,965 (98.59)	21,974 (1.41)	
Ethnicity			
Spanish/Hispanic origin	801,131 (98.94)	8,582 (1.06)	< .001
Not of Spanish/Hispanic origin	3,181,120 (98.32)	54,251 (1.68)	
Multiethnic or ethnicity unknown	808,940 (98.03)	16,275 (1.97)	
Sex			
Female	2,190,487 (98.59)	31,226 (1.41)	< .001
Male	2,600,704 (98.19)	47,882 (1.81)	
Medicaid enrollment (ever)			
No	3,916,422 (98.45)	61,841 (1.55)	< .001
Yes	874,769 (98.06)	17,267 (1.94)	
Child behavioral composite			
No	4,685,174 (98.40)	76,232 (1.60)	< .001
Yes	106,017 (97.36)	2,876 (2.64)	
Child abuse (ever)			
No	4,780,708 (98.38)	78,892 (1.62)	.001
Yes	10,483 (97.98)	216 (2.02)	

Table 2
Adjusted OR for Factors Associated With Fingertip Injuries Among 0- to 12-y-Old Pediatric Patients Presenting in New York State, 2004–2013

Characteristics	Adjusted OR (95% CI)
Age, y (at first visit)	
0	1.00 (reference)
1–2	1.58 (1.55–1.62)
≥ 3	1.56 (1.53–1.59)
Race	
White	1.00 (reference)
Black	0.70 (0.69–0.72)
Asian	0.53 (0.50–0.56)
Other/unknown	0.74 (0.72–0.75)
Ethnicity	
Spanish/Hispanic origin	0.67 (0.65–0.68)
Not of Spanish/Hispanic origin	1.00 (reference)
Multiethnic or ethnicity unknown	1.26 (1.24–1.29)
Sex	
Female	1.00 (reference)
Male	1.28 (1.26–1.30)
Medicaid enrollment (ever)	
No	1.00 (reference)
Yes	1.40 (1.37–1.42)
Child behavioral composite	
No	1.00 (reference)
Yes	1.35 (1.30–1.40)
Child abuse	
No	1.00 (reference)
Yes	1.23 (1.07–1.41)

injury of abuse but one of accidental trauma or a clumsy child. The literature has shown that suspicion of abuse is an important predictor of abuse. Baldwin et al[11] found that a patient history suspicious of abuse or multiple injuries, and a patient aged younger than 18 months were predictive of abuse 92.3% of the time. Identifying children who sustain abuse is crucial to protect children from future abuse. Failure to diagnose patients sustaining first-time abuse results in a 30% to 50% chance of repeat child abuse and a 5% to 10% chance of death.[12,13] Patients who present with these injuries and with a suspicious story may warrant an evaluation by Child Protective Services.

International Classification of Diseases, Ninth Revision diagnosis codes and their relation to abuse and neglect have been reported in the literature. Hospitals are required to use a standardized system of discharge diagnosis codes to be reimbursed for care provided. Schnitzer et al[14] attempted to identify ICD-9 codes suggestive of child maltreatment to increase the usefulness of medical data for public health surveillance. Included in these identified codes were child abuse, unspecified (995.50); child emotional/psychological abuse (995.51); child neglect (nutritional; 995.52); child sexual abuse (995.53); child physical abuse (995.54); shaken infant syndrome (995.55); and other child abuse and neglect/multiple forms of abuse (995.59), all of which were included in the current analysis. We believe these codes to be most predictive of diagnosed abuse or neglect at the time of discharge.

We also analyzed the patient demographics of children presenting with fingertip injuries and found that age greater than 1 year, white race, male, multiethnic or unknown ethnicity, ever having been enrolled in Medicaid insurance, and one or more behavioral characteristics such as depression, ADHD, aggressive behavior, and autism all were associated with an increased probability of presenting with a fingertip injury. Of patients aged 12 years or less presenting to New York State inpatient or outpatient departments, we found that those who had documented abuse or neglect were 23% more likely to sustain a fingertip injury during childhood, which indicates that this injury is more prevalent in children who are abused. These results confirm our anecdotal experience that there is a higher likelihood of child abuse in those who presented with fingertip injuries compared with those who did not.

Limitations of this study pertain to the use of a large administrative database. In particular, inaccurate coding is a potential source of bias. Although we adjusted for all available demographic information, sociological factors are not recorded in the SPARCS database. Other relevant covariates might include location (urban/rural), family factors such as socioeconomic status and domestic violence, and parental factors such as parental age, parental exposure to abuse as a child, marital status, parental substance abuse, homelessness, previous involvement with Child Protective Services, and psychological health. Moreover, because this is an administrative database, we were able to analyze only recorded cases of abuse, which could be subject to missing data. Other limitations of the study include the small number of documented cases of abuse, which could result from a failure to diagnose or inaccurate coding. We also used codes for abuse identified any time during the observation period, which may or may not have been coded at the time of fingertip injury. Therefore, subjects with more follow-up may have been more likely to have abuse coded because they had the opportunity to present more frequently to the inpatient or outpatient setting. Another limitation of the study was that the terms “abuse” and “neglect” can be used interchangeably, and some codes contain both variables, which makes it difficult to decipher which pathology was actually reported. Finally, we were not able to report information on diagnosis codes from physician offices or community health center visits, because these are not in the SPARCS data.

This study found an association between children who sustained fingertip injuries and childhood abuse or neglect. Thus, fingertip injuries may also be an injury resulting from abuse or neglect. If suspected, Child Protective Services should be notified for further evaluation, because failure to diagnose injuries of abuse can lead to future abuse and death. This finding and practice may prevent children from future harm and possible mortality.

Appendix A

ICD-9 Code List for Classifying Injuries, Child Abuse and Neglect, and Child Behavioral Risks

Diagnosis	ICD-9 Diagnosis Code
Fingertip injury	
Amputation	887.0
Avulsion	883.0
Crushed finger	927.3
Child abuse	
Child abuse, unspecified	995.50
Child emotional/psychological abuse	995.51
Child neglect (nutritional)	995.52
Child sexual abuse	995.53
Child physical abuse	995.54
Shaken infant syndrome	995.55
Other child abuse and neglect/multiple forms of abuse	995.59
Child behavioral risks	
Depression	296.3
ADHD	314.01
Aggressive behavior	312.03
Autism	299.00

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