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Short vertical falls in infants

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Objective: **To define injuries from short vertical falls (SVF) in infants, and to compare those with minor or no injuries to those with significant injury.**

Design: **Descriptive, retrospective chart review.**

Setting: **Pediatric emergency department (PED) of an urban teaching hospital.**

Subjects: **Infants ≤ 10 months treated between January 1990 and December 1992 presenting with a SVF (≤4 feet).**

Results: **167 patients met the definition. The mean age was 5.2 months; 56% were male. The mechanisms of injury included rolling off a bed (55%), being dropped from a caretaker's arms (20%), rolling off a couch (16%), and falling from other objects (10%). The majority of patients (85%) had minor or no injury. Significant injuries were sustained by 15% (n = 25), including 16 with a closed head injury (12 with skull fractures), two with intracranial bleed, and seven with a long bone fracture. Subsequently, the two patients with intracranial hemorrhages were confirmed as being from child abuse. After excluding cases of suspected abuse, the only characteristic found to be independently associated with significant injury was being dropped by the caretaker (odds ratio: 6.4 vs rolling or falling from furniture, 95% CI: 2.0, 21.5).**

Conclusion: **The most common mechanism of a SVF was rolling off a bed. Most patients sustained minor or no injury. No child sustained an intracranial hemorrhage from a SVF. The child with intracranial injury and/or multiple injuries warrants an investigation. Being dropped appears to be a greater risk for significant injury than rolling off or falling from furniture.**

INTRODUCTION

Falls are common occurrences in infants and children. Many children do not visit a physician after a minor fall; nonetheless, they are a common chief complaint among patients seeking medical attention. Although they result in a small number of deaths, falls are the leading cause of injury for hospitalization among children and result in approximately 5,000 emergency department visits per year per 100,000 children (1, 2).

A review of the literature reveals conflicting reports regarding the severity of injuries sustained from a short vertical fall (SVF). Reports of injury range from no injury to death. Helfer et al. (3) found that of 246 children aged 5 years and younger who fell from the height of a bed or sofa (3 feet or less), none suffered any life-threatening injuries from their falls, although three patients sustained an isolated skull fracture. Duhaime and others (4) studied 100 patients younger than 2 years of age hospitalized for a head injury. The results confirmed that simple falls from low heights (<4 feet) rarely, if ever, result in significant brain injury. Likewise, studies reviewing the incidents of children falling out of bed, a crib, or a chair while in the hospital have found that such falls rarely, if ever, result in serious injury (5, 6).

Other investigators have reached different conclusions. Williams' study (7) of falls from a variety of heights in children less than 3 years of age compared uncorroborated falls with witnessed, corroborated falls. Three patients falling between 4 and 5 feet had small depressed skull fractures in the witnessed group; however, severe injuries were common in falls of less than 5 feet in the uncorroborated group, and there were two deaths from falls of less than 5 feet in this group. Hall et al. (8), in a review of medical records of 44 children who died from falls, found that these deaths included 18 children less than 15 years of age who fell while running or from a distance less than 3 feet. These children all died from head injuries without any associated injury. The authors concluded that "minor falls can be lethal, especially in a toddler, and must be evaluated." Chadwick and others (9) reviewed 317 charts and discovered seven deaths in 100 children who fell 4 feet or less. They concluded that falls of less than 4 feet are often reported in association with children's head injuries that prove to be fatal, but such histories are inaccurate in all or most such cases.

Previous studies have included children and infants of ages with fairly heterogeneous mechanisms of falls. In contrast to previously cited studies, an investigation was undertaken to define injuries resulting from short vertical falls in preambulatory infants only and compare characteristics of those who sustain no or minor injuries with those who suffer significant injuries. Benefits of this approach are: 1) risk of abuse and serious injury may be higher in infants than in toddlers and older children, 2) patterns of injury may be different in simple vertical falls in contrast to those involving running and climbing, and 3) the chief complaint of an infant being dropped or rolling off furniture is very common in the PED.

METHODS

A review of the ED log was undertaken to identify all infants who presented to the PED between January 1, 1990 and December 31, 1992 with a presenting complaint of a fall, being "dropped" or a head injury.

The study group was restricted to infants ≤10 months of age who presented with a history of a vertical fall less than or equal to 4 feet. For the purposes of the study, these falls were defined as those resulting from rolling off a bed, couch, or other surface, or being dropped by a caretaker. Ten months was chosen as the age limit to obtain a population of predominately preambulatory infants. To exclude infants injured from forces or trajectories other than those

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generated in a short vertical fall, we excluded all those with falls from car seats or infant seats, falls down stairs, walker-related injuries, and all falls occurring as a result of climbing, cruising, walking, or running, as well as infants who struck objects and those whose caretakers fell on them.

Data collected included age (months); gender; race (African-American, Caucasian, Other); insurance status (Self-pay, Medicaid, Commercial); injury mechanism; physical examination findings; radiographic studies and results; discharge diagnosis; disposition; documentation of referral to Division of Family Services (DFS); and documentation regarding injury prevention.

For the purposes of analysis, physical examination findings were categorized as no evidence of injury, minor injury, or significant injury. Minor injuries were defined as superficial injuries that did not require hospitalization for medical reasons and included abrasions, bruises, minor lacerations, and contusions. Significant injuries were defined as all fractures, intracranial hemorrhage (ICH), visceral injury, and any injury requiring hospitalization for medical reasons.

A child abuse work-up is initiated on all children in whom a suspicion of child abuse exists. At our institution, this typically starts with a consult to social services. The social worker interviews the child, family, and/or caregiver and notifies the DFS. The child then undergoes a thorough medical examination, including a physical examination, and appropriate laboratory and radiographic studies. The DFS investigates all suspected cases of child abuse within 24 hours and makes a recommendation regarding disposition of the child.

A univariate analysis was performed comparing demographic and historical factors among patients with significant injury and those with minor or no injuries combined with chi-square analysis using EPI-INFO version 6 (10). Statistical significance was set at $P < 0.05$. In patients in whom abuse was not suspected, variables were assessed for independent association with a risk of significant injury with a multiple logistic regression using EGRET statistical software (11).

RESULTS

A total of 167 patients met the case definition. The mean age was 5.2 months (range 0.5–9.75 months). Slightly over half of the patients were male. African-American and Caucasian patients composed 68.9 and 22.1% of the study group, which reflected our PED population. Almost 78% of patients were insured by Medicaid, 12.0% had some form of commercial insurance, and 10.2% had no form of health insurance (Table 1), which reflected our PED population.

The most common mechanism of injury was rolling off a bed ($n = 91$, 54.5%), followed by being dropped by a caretaker ($n = 34$, 20.4%), and rolling off a couch ($n = 26$, 15.6%). The remainder of falls were from miscellaneous objects, including chairs ($n = 6$), changing tables ($n = 4$), and one infant each who fell from a lap, a slide, a dryer, a shelf, a counter, and a porch.

Nearly 40% of the case infants had no evidence of injury on physical examination, and 45.4% had only minor injury, including abrasions, contusions, hematomas, and minor lacerations. One infant sustained a superficial burn and one a conjunctival hemorrhage. Significant injuries were present in 25 (15.0%) patients. They included seven patients with long bone fractures (three femur, one humerus, two tibia, one clavicle) and 18 patients with a closed head injury (CHI). Of the seven patients with long bone fractures, a child abuse hotline referral was made in four. All four underwent a radiographic skeletal survey; none were found to have occult fractures. Three of these four patients were admitted and all were dismissed to their parents' care. Of the 18 patients with CHI, two sustained an intracranial hemorrhage and both were subsequently discovered to be victims of child abuse. The remaining patients had a CHI either with ($n = 12$) or without ($n = 4$) a linear skull fracture. A child abuse hotline referral to DFS was made in 3 of the 12 patients with skull fractures. One of the three was ultimately admitted to the hospital for suspicion of child abuse and eventually placed in foster care.

Eighteen (10.8%) of the study group were hospitalized, three of the 142 (2.1%) with minor injury and 15 of the 25 (60%) with significant injury. Documentation regarding parental education on infant fall prevention was present in 13 cases (7.8%). A skeletal survey was performed in 10% of all patients and 48% of patients with significant injury. Documentation of suspicion of physical abuse and child abuse hotline referral was present in 10% of all patients and 40% of patients with significant injury. In the group with significant injury, those patients for whom a child abuse hotline referral was made did not differ significantly from the group not referred to the hotline with regard to race, age, insurance status, or mechanism of injury.

TABLE 1

Selected characteristics of the study population ($n = 167$)

	n	%
Age		
0–4.9 months	70	41.9
5–10 months	97	58.1
Sex		
Female	74	44.3
Male	93	55.7
Race		
African-American	115	68.9
Caucasian	37	22.1
Other	15	9.0
Insurance status		
Commercial	20	12.0
Medicaid	130	77.8
None	17	10.2
Mechanism of injury		
Dropped by caretaker	34	20.4
Rolled off/fell from		
Bed	91	54.5
Couch	26	15.6
Other[a]	16	9.6
Injuries		
None	66	39.5
Minor[b]	76	45.4
Significant		
Intracranial hemorrhage (ICH)	2	1.2
Closed head injury without ICH		
With skull fracture	12	7.2
Without skull fracture	4	2.4
Long bone fracture	7	4.2
Radiographic studies		
Plain films		
Skull	22	13.2
Skeletal survey	16	9.6
Cervical spine	6	3.6
Long bone	9	5.4
Other	4	2.4
CT head	11	6.6
Hospitalized	18	10.8

[a]Other includes falls off chairs ($n = 6$), changing tables ($n = 4$), and miscellaneous objects ($n = 6$, see text).

[b]Minor injuries defined as abrasions, hematomas, minor lacerations, and contusions.

Suspicion of child abuse was substantiated in the two patients with intracranial hemorrhage after caretakers recanted the original history. One infant presented with an initial history of rolling off the couch. A social service investigation was conducted by DFS, and the mother admitted that the child was struck in the head by a stereo speaker thrown during a domestic dispute. The child was admitted to the hospital and discharged to foster care. The second infant was transferred to the PED from an outlying hospital with a history of rolling off the couch. An investigation conducted by DFS revealed that the father shook the child in a moment of anger. This child was admitted to the hospital and dismissed to the care of his grandparents.

Demographic and historical factors of the study group divided by occurrence of significant injury are shown in Table 2. In a multiple logistic regression model, restricted to children in whom abuse was not suspected (n = 153), infants with a history of being dropped from a caretaker's arms were significantly more likely to be seriously injured than infants with other fall mechanisms (OR 6.5, 95% CI 2.0, 21.8). There was no significant association between age, gender, race, or insurance status and presence of a significant injury in the multivariate analysis in this group. In addition, those with significant injuries were 17 times more likely to have a skeletal survey ordered (48% vs 2.8%) and 10 times more likely to have a report made to DFS (40% vs 4.2%) than those with no or minor injury.

DISCUSSION

Unlike previous studies of childhood falls, this study addresses typical short vertical falls in a population of primarily preambulatory infants who have seemingly benign occurrences such as falling from a bed, a couch, a changing table, or the arms of a caretaker. The majority (85%) of the patients sustained no injury or minor injury. A typical physical finding was a minor hematoma or a contusion. No child sustained an ICH from a short vertical fall, although two abused infants with ICH presented with an initial-false history of having fallen a short distance. A significant number of patients (11.4%) sustained an isolated linear skull or long bone fracture from a short vertical fall. Unfortunately, abuse cannot be absolutely ruled out on the basis of this retrospective review.

Physicians are often called upon to make judgments about the potential for child abuse when the injuries sustained seem inconsistent with the history reported. A significant amount of debate exists in the literature regarding the type and extent of injuries in children resulting from a short fall. Similar to studies by Helfer et al. (3), Nimityongskul and Anderson (5), Duhaime et al. (4), and Lyons and Oates (6), this study emphasizes the lack of life-threatening injury or intracranial injury in infants who fall short distances. However, significant, although not life-threatening, injuries such as long bone fractures and linear skull fractures were not uncommon.

The major limitations of the study include the potential unreliability of the history and the retrospective design. Documentation of whether the event was witnessed, what body part impacted, and whether there was loss of consciousness was often lacking. Whether this was due to actual lack of availability of the information or failure by the physician to ascertain it, is not known. Two patients with initial histories of rolling off a couch and serious intracranial injuries were subsequently found to have been abused. Clearly there could be additional patients whose initial histories were falsified in an attempt to cover up child abuse. In addition, there were other instances where child abuse was initially suspected but not substantiated. This was especially true for the infants with the humerus fracture, femur fracture, and burn. As follow-up was limited to those patients who returned to our center, those with follow-up elsewhere could not be substantiated. Since we are the regional child protection center, our suspicion is low that follow-up occurred elsewhere. Further prospective studies with follow-up and social services investigation might delineate those patients with a suspicious mechanism of injury.

A child with a significant injury was statistically more likely to have been dropped from the arms of a caretaker. Rolling off a bed was less likely to result in a significant injury than other mechanisms. Because of a lack of consistent documentation, surface of impact, and body part of impact were not identified. A child dropped from the arms of a caretaker probably fell a greater distance and perhaps more often struck a harder surface than a child rolling off a bed or a couch who may have been more likely to strike a carpeted surface. Interestingly, two independent studies of stairway falls found that a marker for a more serious injury was being carried by a caretaker (12, 13). The biomechanics of a fall from

TABLE 2

Selected characteristics of study population by occurrence of significant injury

	None/minor injury n = 142 (85.0%)		Significant injury n = 25 (15.0%)		
	n	%	n	%	p value[a]
Age					
0–4.9 months	57	40.1	13	52.0	NS (.81)
5–10 months	85	59.9	12	48.0	
Sex					
Female	65	45.8	9	36.0	NS (.54)
Male	77	54.2	16	64.0	
Race					
African-American	103	72.5	12	48.0	NS (0.08)
Caucasian	28	19.7	9	36.0	
Other	11	7.8	4	16.0	
Insurance status					
Commercial	15	10.5	5	20.0	NS (.64)
Medicaid	114	80.3	16	64.0	
None	13	9.2	4	16.0	
Mechanism					
Dropped by caretaker	23	16.2	11	44.0	.003
Rolled/fell from	119	83.8	14	56.0	

[a]Independently associated with significant injury by logistic regression. NS = P value > 0.05.

a caretaker's arms may be different. Further studies may help to clarify the velocity and forces of being dropped from a caretaker's arms versus rolling off a bed or other stationary object. Perhaps pediatricians should warn parents and caretakers to pay greater attention to carrying infants more carefully.

Unfortunately this study does not definitively answer the question of whether the mechanism of falling a short distance can result in a skull fracture or a long bone fracture in a young infant. Prospective studies are necessary to further define injuries sustained by infants who have short vertical falls; such a study is being initiated at our center, using a standardized data collection instrument.

Most of the time short vertical falls in infants do not result in significant injury. Significant injuries or multiple injuries, when they occur, should raise the suspicion of child abuse. If the injury is an intracranial hemorrhage, the suspicion should be even higher, and a thorough child abuse evaluation is warranted. The majority of infants were not injured or sustained minor injury, most commonly a hematoma/contusion. No child sustained significant intracranial injury from a short vertical fall, and no child sustained multiple significant injuries or visceral injuries from a short vertical fall.

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