Are Height and Weight Associated with Mechanism of Injury for a Toddler's Fracture? A Retrospective Evaluation of Playground Related Toddler's Fractures

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Introduction

The toddler's fracture, a non-displaced spiral fracture of the tibial shaft, is one of the most common lower extremity injuries in children ages 1-3 years old[1,2]. This fracture pattern is thought to be due to a twisting force to the lower leg which can occur after a child falls or gets their foot caught on a playground slide[3,4,5]. Playground slide injuries are one of the most common causes of toddler's fractures[6,7].

Although the association between playground slides injuries and lower extremity fractures has been explored, studies specifically evaluating toddler's fractures and slide related injuries are limited[6,8,9]. Given the increasing incidence of playground related injuries[6,10], there is a need for an updated understanding of the factors that place patients at risk for toddler's fractures in order to provide adequate guidance to parents and federal regulations.

The purpose of this study is to evaluate if there are demographic differences between patients who sustained a toddler's fracture on a slide versus a non-slide injury and those riding in the lap of an adult versus alone.

Materials and Methods

We performed a retrospective cohort study evaluating all patients, ages 5 months to 11 years, who were diagnosed with a nondisplaced spiral shaft fracture of the tibia at a single tertiary pediatric hospital between 2015-2021. Patients who had a displaced spiral tibial shaft fracture, non-spiral tibial shaft fracture, or concomitant fibula fracture were excluded from the study. Authors collected demographic, injury, and treatment data for all patients who met inclusion criteria.

Standard descriptive statistics were used to report demographic variables and bivariate analyses were conducted to identify demographic differences between patients with slide versus non-slide injuries and those riding alone versus riding in the lap of an adult.

Results

Of the 652 pediatric injuries, 230 (35%) were displaced tibial shaft fractures, non-spiral tibial shaft fractures, or had concomitant fibula fractures, and 15 (4%) were missing mechanism of injury, leaving 407 available for analysis. Demographic, injury, and treatment details are presented in Table 1.

Over 90% of slide injuries occurred in patients who were 0 to 3 years old, while only 67% of non-slide injuries occurred in the same age group ($p < 0.001$). Patients injured going down slides were significantly shorter ($p<0.001$) and lighter weight ($p<0.001$) than those who experienced non-slide injuries (Table 2). When controlling for age, including only patients 0-3 years old, patients injured on a slide were still significantly shorter and weighed less than those who experienced non-slide injuries (32.9 +/− 2.49 inches versus 33.78 +/− 2.70 inches, $p = 0.046$;12.38 +/− 1.86 kg versus 13.00 +/− 2.49 kg, $p = 0.01$). There were proportionally fewer slide related toddler's fractures for children above 30 inches and 20 kilograms (Figure 1).

The majority of slide injuries occurred when riding in the lap of an adult (68%). However, there were no significant demographic differences between those who were injured while riding alone versus riding in the lap of an adult (Table 2).

Discussion

Our retrospective cohort study demonstrated that patients who developed a toddler's fracture from a slide related injury were significantly younger than those who were injured via other mechanisms. Patients injured on a slide were also significantly shorter and weighted less, even when controlling for age, and there were proportionally fewer slide related fractures for children above 30 inches and 20 kilograms. We were unable to identify a subgroup of patients based on demographic characteristics that

Table 1. Population Demographics for Toddler's Fractures

Characteristics	Variable		Total Population (n= 407)
Demographic Characteristics	**Age at Injury (years)**		2.05 (1.5 to 3)
		0-3 years	305 (75%)
		3-6 years	73 (18%)
		6-9 years	23 (6%)
		9 and older	6 (1%)
	Height (inches)		35.98 (32.8 to 43.8)
	Weight (kg)		13 (11.34 to 15.2)
	Sex		
		Male	253 (62%)
		Female	154 (38%)
	Race		
		Caucasian	291 (72%)
		African American	48 (12%)
		Asian	13 (3%)
		Other	49 (12%)
		Refused	6 (1%)
	Ethnicity		
		Non-Hispanic	399 (98%)
		Hispanic	8 (2%)
		Laterality	
		Right	220 (54%)
		Left	187 (46%)
Injury Characteristics	**Mechanism of Injury**		
		Fall	198 (49%)
		Playground Injury (Slide)	131 (32%)
		Playground Injury (Other)	22 (5%)
		Sports	9 (2%)
		MVC	1 (1%)
		Other (Collision or unwitnessed)	46 (11%)
	Initial Treatment		
		Long Leg Cast	272 (67%)
		Short Leg Cast	57 (14%)
		Splint	57 (14%)
		CAM Boot	20 (5%)
Treatment Characteristics	**Complications**		
		Skin breakdown from cast	7 (2%)
		Reinjury after cast removal	5 (1%)
		Compartment Syndrome or Neurovascular Injury	0 (0%)
	Length of Follow Up (days)		29 (23 to 42)

Data is presented as n(%), mean +/− SD, or median (IQR)

Table 2. Evaluating Demographic Differences for Toddler's Fractures

Slide versus Non-Slide Injuries

Parameter		Slide Injuries (n=131)	Non-Slide Injuries (n=276)	Chi Square	P value
Age at Injury (years)		1.85 +/− 0.683	3.02 +/− 2.07		**<0.001[a]**
Age at Injury (years)					
	0-3 years	121 (92%)	184 (67%)	33.026	**<0.001[b]**
	3-6 years	10 (8%)	63 (23%)		
	6-9 years	0 (0%)	23 (8%)		
	9 and older	0 (0%)	6 (2%)		
Height (inches)		33.37 +/− 2.90	38.33 +/− 6.93		**,0.001[a]**
Weight (kg)		12.44 +/− 1.98	15.86 +/−- 7.79		**,0.001[a]**
Sex				0.609	0.435[b]
	Male	85 (65%)	168 (61%)		
	Female	46 (35%)	108 (39%)		
Laterality				0.149	0.75[b]
	Right	69 (53%)	151 (58%)		
	Left	62 (47%)	125 (42%)		

Sliding Alone vs Sliding in lap of an Adult

Parameter		Sliding Alone (n=42)	Sliding in lap of Adult (n=89)	Chi Square	P value
Age at Injury (years)		2.07 +/− 0.80	1.75 +/− 0.60		**0.057a**
Age at Injury (months)				6.892	0.142[b]
	0-11 months	1 (2%)	2 (2%)		
	12-23 months	20 (48%)	63 (70%)		
	24-35 months	16 (38%)	19 (21%)		
	36 - 47 months	4 (10%)	4 (4%)		
	48 -59 months	1 (2%)	1 (1%)		
	60-72 months	0 (0%)	0 (0%)		
Height (inches)		34.21 +/− 2.99	32.95 +/− 2.79		0.071[a]
Weight (kg)		12.87 +/− 2.1	12.23 +/− 1.91		0.094[a]
Sex				0.47	0.493[b]
	Male	29 (69%)	56 (63%)		
	Female	13 (31%)	33 (37%)		
Laterality				4.857	**0.028[b]**
	Right	28 (67%)	41 (46%)		
	Left	14 (33%)	48 (54%)		

Data is presented as n(%), mean +−- SD, or median (IQR). a- Independent T tests, b- Pearson Chi square test. P values listed in bold indicate significance less than 0.05

would be more likely to be injured when riding down a slide in the lap of an adult versus riding alone.

Our study mirrors earlier epidemiologic studies demonstrating that toddler's fractures are a common pediatric lower extremity injury that primarily occur after falls and playground injuries[2, 6,8,11]. Given the increasing incidence of playground related injuries in recent years[6,10] in conjunction with our finding that over one third of toddler's fractures result from playground slide injuries, there is a need for an updated understanding of the factors that place patients at risk for these injuries in order to provide adequate information for federal interventions such as the US Consumer Product Safety Commission (CPSC). The CPSC has recommendations on age-appropriate playground equipment, however there are

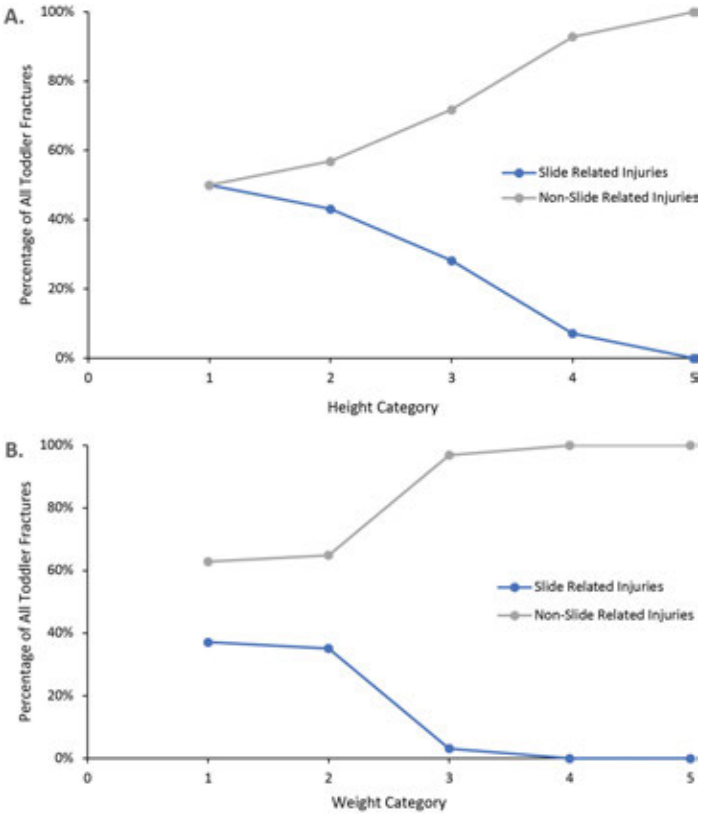

Figure 1. Percent of all Toddlers Fractures as a function of height and weight. Panel a) The height categories are as follows: 1: 25-30 inches, 2: 30-35 inches, 3:35-40 inches, 4:40-45 inches, 5:45+ inches. Panel b) The weight categories are as follows: 1: 0-10kg, 2:10-20kg, 3:20-30 kg, 4: 30-40 kg, 5: 40+ kg.

no current height, or weight restrictions regarding playground slide use[12]. Based on the average height and weight of children in the US, our findings suggest that children up to age 4-5 years old may be at an elevated risk of a slide related injury[13].

Riding on the lap of an adult on a slide also poses serious risk for a child. Recent literature suggests that children less than 3 years old were over 12 times more likely to be identified as being on a lap at the time of injury as compared to older children[6]. While our study demonstrated that the highest proportion of slide injuries occur in children younger than 3, we did not find a difference in the age between those who rode the slide alone and those who rode in the lap of an adult. One possible reason for this difference is that the prior study included all lower extremity injuries while our study solely evaluated toddler's fractures. However, given that the highest proportion of slide related injuries occurred in children 0-3 years old, our recommendation is that parents exhibit extreme caution when allowing children less than 3 years old to go down slides either alone or accompanied by an adult.

This study is limited by the retrospective design and the geographic location of this single center study.This study was also not designed to assess whether quarantine restrictions during the COVID-19 pandemic influenced the demographics or common mechanism of injury. Previous research has demonstrated there was an overall decrease in playground related injuries during the first months of the COVID-19 pandemic[14]. Finally, given that many toddler's fractures are occult it is unclear if there are demographic differences between patients included in the study and those that were not evaluated for injury.

Conclusion

Height and weight are associated with mechanism of injury for toddler's fracture, and parents must use extreme caution when a child under 30 inches or 20 kg rides a slide.

References

1. Rennie L, Court-Brown CM, Mok JY, *et al.* The epidemiology of fractures in children. Injury 2007 Aug; 38(8): 913-22.

2. Wang Y, Doyle M, Smit K, *et al.* The Toddler's Fracture. Pediatr Emerg Care 2022; 38(1): 36-39.

3. John SD, Moorthy CS, Swischuk LE. Expanding the concept of the toddler's fracture. Radiographics 1997 Mar-Apr; 17(2): 367-76.

4. Alqarni N, Goldman RD. Management of toddler's fractures. Can Fam Physician 2018; 64(10): 740-741.

5. Pattishall AE. An Updated Approach to Toddler Fractures. J Urgent Care Med 2019.

6. Jennissen, C.A., Koos, M., Denning, G. Playground slide-related injuries in preschool children: increased risk of lower extremity injuries when riding on laps. Inj. Epidemiol 2018; 5 (13).

7. Naranje SM, Erali RA, Warner WC Jr, *et al.* Epidemiology of Pediatric Fractures Presenting to Emergency Departments in the United States. J Pediatr Orthop 2016 Jun; 36(4): e45-8

8. Gaffney JT. Tibia fractures in children sustained on a playground slide. J Pediatr Orthop 2009;29(6): 606–8.

9. Seguin, J., Brody, D., Li, P. Nationwide survey on current management strategies of toddler's fractures. CJEM 2018; 20(5): 739-745.

10. Cheng TA, Bell JM, Haileyesus T, *et al*. Nonfatal playground-related traumatic brain injuries among children, 2001-2013. Pediatrics 2016;137(6).

11. Bae S, Lee JS, Kim KH, *et al.* Playground equipment related injuries in preschool-aged children: emergency department-based injury in-depth surveillance. J Korean Med Sci 2017;32(3):534–41.

12. U.S. Consumer Product Safety Commission. Public playground safety handbook 2015. Available at: https://www.cpsc.gov/s3fs-public/325.pdf. Accessed 24 Jan 2022.

13. Centers for Disease Control and Prevent Growth Charts. 2000 CDC Growth Charts for the United States. https://www.cdc.gov/growthcharts/cdc_charts.htm. Accessed 27 Jan 2022.

Bram JT, Johnson MA, Magee LC, *et al*. Where Have All the Fractures Gone? The Epidemiology of Pediatric Fractures During the COVID-19 Pandemic. J Pediatr Orthop 2020 Sep;40(8): 373-379.