

Craniofacial Trauma from Electronic Scooter Use

LUKE SOLIMAN, MTS; KENNY CHANG, BA; NICHOLAS SAWICKI; NIKHIL SOBTI, MD; RONALD K. AKIKI, MD; SOLOMON SWARTZ, MD; LAUREN O. ROUSSEL, MD; ALBERT S. WOO, MD

ABSTRACT

BACKGROUND: In 2018, the City of Providence introduced a program in which electronic scooters were deployed for public use. We aim to characterize the burden of craniofacial injuries associated with these scooters.

METHODS: A retrospective review was conducted of all patients consulted to the plastic surgery service for evaluation of craniofacial injury between September 2018 and October 2022. Data pertaining to patient sociodemographics, site and time of injury, and craniofacial trauma were recorded.

RESULTS: Twenty-five patients sustaining craniofacial trauma were identified over a four-year period. Most patients required soft tissue repair (64%) and bony fractures were sustained by approximately half of all patients (52%). Admission to ICU was uncommon (16%), and there were no fatalities.

CONCLUSIONS: The incidence of craniofacial injury from electronic scooter use is low. However, these injuries may involve extensive surgical reconstruction and ICU admission. We advise the City of Providence to optimize best safety practices and monitoring to minimize risk.

KEYWORDS: craniofacial, trauma, e-scooter, vehicle

INTRODUCTION

In the fall of 2018, the city of Providence, Rhode Island, initiated a “Shared Micromobility Program” to enhance the city’s existing transportation offerings.¹ This ongoing initiative has been pioneered with the intent of “creating a safe, well-connected community.” As part of this effort, a significant number of commercial electronic scooters have been deployed across the city for public use. This campaign comes about during a period of significant national expansion of the electronic scooter enterprise. Since 2010, over half a billion rides using these vehicles have been recorded in the United States.² Scooters may be easily accessed through a smartphone application and accompanying mobile payment by credit card. To ensure rider and pedestrian safety, the City of Providence has set a variety of measures in place. Among

these, steps include that riders obey all traffic laws, do not operate these vehicles while intoxicated, and possess a valid driver’s license.

At Rhode Island Hospital, the Department of Plastic and Reconstructive Surgery evaluates hundreds of patients who sustain craniofacial trauma on an annual basis. Injuries occur through a variety of mechanisms, with motor vehicle collision contributing a significant number of these injuries. Management may be limited to soft tissue laceration requiring suture repair in the emergency department; however, some patients may sustain significant additional bony injury requiring extensive surgical reconstruction in the operating room. Additionally, patients may experience other bodily injuries beyond the face, each of which require their appropriate medical or surgical management. In this study, we seek to evaluate the burden of craniofacial trauma from electronic scooter use in Providence, Rhode Island, following the introduction of these vehicles in the fall of 2018.

METHODS

This study adheres to all pertinent institutional research policies and procedures, and institutional review board approval was obtained and maintained throughout the study period. A retrospective review of a prospectively maintained Research Electronic Data Capture (REDCap) database was performed for all patients evaluated by the plastic surgery department at Rhode Island Hospital who suffered craniofacial trauma following electronic scooter use. The study period began in September 2018, coinciding with the introduction of electronic scooters to Providence, Rhode Island, until October 2022.

Patient demographic data, such as age at presentation, sex, race, ethnicity, and occupation were extracted from the medical chart. Recorded social history included insurance status, as well as prior history of smoking, alcohol, or illicit drug use. Data relating to active substance use, such as blood alcohol concentration (BAC) and urine toxicology were also abstracted. Other factors surrounding the circumstances of injury were retrieved, such as date, time of day, mechanism (fall versus collision), and use of helmet.

Clinical characteristics relating to craniofacial injury were also recorded, including presence and region of soft tissue or

bony trauma. The necessity of surgery for craniofacial injury was also documented. Trauma to extremities, solid organs, pelvic region, spine and brain were recorded. Referral for operative management of these other injuries was also documented. Outcomes such as length-of-hospital stay, intensive care unit (ICU) admission and fatality were extracted from the medical record. Data were analyzed using IBM SPSS Version 25 (IBM Corp., Armonk, N.Y.). Patient and injury characteristics were summarized using descriptive statistics.

RESULTS

Among 26 patients sustaining craniofacial injury following electronic scooter trauma, 1 was excluded due to insufficient data. Of the 25 included patients, the mean age was 33.5 ± 18.2 years, and 56% were male (Table 1). Most patients were White (64%). Included subjects were split similarly amongst employed (32%), unemployed (36%), and student (28%) occupational statuses. Most patients were insured (88%). Two-thirds of patients had a prior documented history of illicit drug use (64%).

Collectively, summer months (May–August) accounted for the greatest burden of craniofacial injury (64%) (Table 2). Most injuries occurred during the period of 12:00pm to 12:00am (84%). A temporal distribution of these injuries by month and time of day is shown graphically in Figure 1. Helmets were infrequently used (48%). Falls were the most common mechanism of injury (60%). However, collisions with stationary objects and other vehicles constituted a significant minority (40%). Blood alcohol concentration was tested in nearly half of patients (44%), and the mean BAC in tested patients was 156.5 ± 141.8 mg/dL. Urine toxicology was tested in approximately one third of patients (32%) and was most frequently positive for marijuana (37.5%, 3/8).

Of the included patients, 17 sustained significant soft tissue injury (68%), with 16 (64%) requiring repair in either the emergency department or operating room (Table 3). These injuries most frequently occurred to the lips (28%), nose (20%) and chin (20%). Bony fractures were experienced by approximately half of all patients (52%), with trauma most frequently occurring to the zygomaticomaxillary complex (32%), orbit (24%), and frontal bone (16%). A minority of patients were referred for operative repair of bony injuries (16%).

Other bodily injuries were common among this cohort (60%), the most frequent of which was tooth avulsion (24%) (Table 4). Significant trauma such as traumatic brain injury (16%) and intracranial bleeding (12%) occurred in approximately 1 in 8 patients. Of patients sustaining other bodily injuries beyond craniofacial trauma, 12% were referred for surgical management of these injuries.

Table 1. Sociodemographic characteristics of included patients.

	Frequency (n = 25)	Percent (%)
Age		
Mean \pm SD	33.5 \pm 18.2	
Median (min–max)	34.1 (5.5– 65.2)	
Sex		
Male	14	56
Female	11	44
Race		
White	16	64
Asian	3	12
Black or African American	0	0
American Indian or Alaska Native	0	0
Native Hawaiian or Other Pacific Islander	0	0
Other	6	24
Hispanic Ethnicity		
Yes	5	20
No	20	80
Occupation		
Unemployed	9	36
Employed	8	32
Student	7	28
Not Documented	1	4
Insured		
Yes	22	88
No	3	12
Primary Insurance		
Private	20	80
Other	1	4
Medicaid	1	4
Previous History of Substance Use		
Yes	16	64
No	9	36
Previous History of Tobacco Use		
Yes	6	24
No	19	76
Previous History of Alcohol Use		
Yes	6	24
No	19	76
Previous History of Drug Use		
Yes	2	8
No	23	92

Table 2. Data surrounding circumstances of electronic scooter injury.

	Frequency (n = 25)	Percent (%)
Month of injury		
January	0	0
February	0	0
March	0	0
April	1	4
May	3	12
June	3	12
July	6	24
August	4	16
September	1	4
October	3	12
November	3	12
December	1	4
Time of day of injury		
6pm–12am (evening)	12	48
12pm–6pm (afternoon)	9	36
6am–12pm (morning)	2	8
12am–6am (late night/early morning)	2	8
Trauma mechanism		
Fall	15	60
Collision with stationary object	6	24
Collision with vehicle	4	16
Multiple riders		
Yes	1	4
Undocumented	24	96
Helmet use		
Yes	5	20
No	12	48
Unknown	8	32
Blood alcohol concentration tested		
Yes	11	44
Blood Alcohol Concentration, mg/dL (mean ± SD)	156.5 ± 141.8	
Urine toxicology tested		
Marijuana (+)	3	12
Cocaine (+)	1	4
Opioids (+)	2	8
Benzodiazepine (+)	1	4
Other (+)	2	8

Figure 1. Temporal distribution of electronic scooter accidents by time of day and month of year.

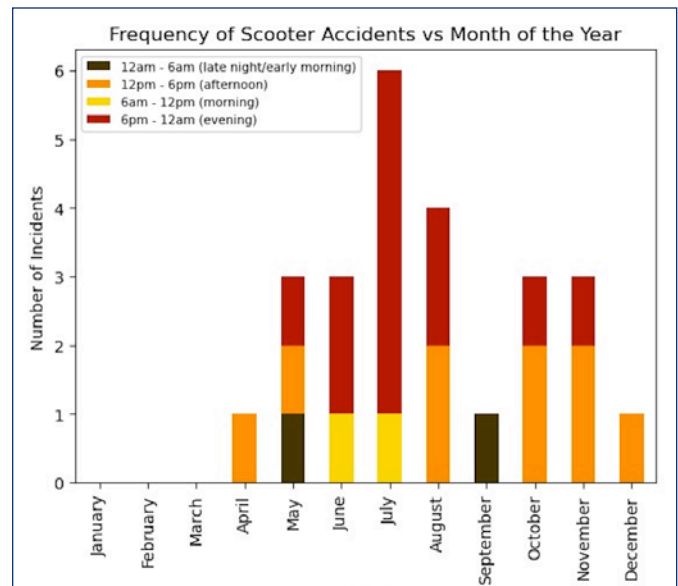


Table 3. Distribution of soft tissue and bony injury by anatomic region, as well as frequency of patients requiring soft tissue repair and operative intervention.

	Frequency (n = 25)	Percent (%)
Soft tissue injury	17	68
Forehead	4	16
Nasal	5	20
Cheek	2	8
Lip	7	28
Chin	5	20
Soft tissue repair	16	64
Bony Fracture	13	52
Calvarial	2	8
Frontal bone	4	16
Orbital	6	24
ZMC	8	32
NOE	0	0
Nasal bone	3	12
Le Fort I	0	0
Le Fort II	0	0
Le Fort III	1	4
Mandible	3	12
Surgery for fracture repair	4	16

Table 4. Distribution of bodily injuries beyond craniofacial trauma as well as frequency of their surgical management.

	Frequency (n = 25)	Percent (%)
Other bodily injury	15	60
Tooth avulsion	6	24
Extremity injury	2	8
Solid organ injury	2	8
Pelvic injury	1	4
Spine injury	1	4
Thoracic injury	3	12
Traumatic Brain Injury	4	16
Intracranial Bleeding	3	12
Surgical management of injury	3	12

Table 5. Mortality and length of hospital stay following electronic scooter injury.

	Frequency (n = 25)	Percent (%)
Hospital Stay, days (mean ± SD)	2.2 ± 4.9	
ICU Admission	4	16
Fatal injury	0	0

The median length of hospital stay was 0 days (range, 0–19), with 15 patients (60%) undergoing discharge directly from the emergency department. After excluding these patients, the median length of hospital stay was 2 days (range, 1–19). Two patients underwent hospital stays for a period of 17 days or greater, each of whom sustained intracranial bleeding. Approximately 1 in 7 patients required ICU admission (16%) due to non-craniofacial injuries. There were no recorded fatalities.

DISCUSSION

In this study, we evaluated the burden of craniofacial trauma in a single center due to electronic scooter use since their public introduction by the City of Providence in the fall of 2018. We discovered that, over the four-year period of this retrospective study, there were 25 craniofacial injuries meeting inclusion criteria for which the Department of Plastic and Reconstructive Surgery was consulted. This equates to approximately 6 injuries each year. We therefore believe that the incidence of craniofacial injury is acceptably low in Providence, given that these vehicles are likely in operation for hundreds of instances each week. However, as infrequent as these injuries may occur, they can be significant requiring surgical reconstruction, ICU admission, and lengthy hospital stay.

There are several key findings from this investigation. The mean age of 33.5 years and distribution of occupation status is different from what was hypothesized. We suspected that most injuries would occur amongst high school and college students from across the Providence area, given the density

of educational institutions and younger individuals in the municipality. However, we discovered that students comprise the minority of these injuries (28%) and that most of these injuries were sustained by adults beyond college age. While the patient demographic results were surprising, the temporal data surrounding the site of injury were in line with expectations. Most injuries occurred during the summer months and in the afternoon or evening time of day. We advise that the City of Providence should exercise distinct caution during these periods to ensure rider safety. Of the riders tested for blood alcohol concentration, the average value was approximately double the legal limit for operation of a motor vehicle in Rhode Island. We believe this finding may be of use to the city during periods of heightened caution. In addition, we discovered that nearly half (48%) of patients did not have documented helmet use; in one third (32%) of cases, helmet use was unknown. In the interest of safety, we additionally advise the city to encourage practicing helmet usage among riders, as well as promoting helmets available for rent. Other safety measures may take place through formal notices applied to each scooter emphasizing the risks of vehicle use while intoxicated and without a helmet. Given the low incidence of significant injury with these motorized scooters, we believe they are generally safe with proper use and best safety practices, as with operation of any motor vehicle.

The patterns of craniofacial injury observed in this study following electric scooter trauma are similar to previously published investigations.^{3,4} Faraji et al noted greatest frequency of soft tissue injury among the lips, chin and forehead aesthetic units, which we recapitulate in this study.⁴ Similarly, the same study identifies the greatest number of bony injuries among the orbit, zygomaticomaxillary complex and nasal bones, which we too identify. These aesthetic units and bony complexes are anteriorly based, suggesting that electronic scooter injury may involve a head-on collision or forward fall.

This study bears limitations. Our estimate of injury incidence is likely deflated, as it does not capture patients who did not present to care, as well as those patients who presented to the emergency department but were not seen by plastic surgery. Severe injuries leading in death would also not have been seen in the emergency department. Many patients with minor facial soft tissue laceration may be repaired in the emergency department without a specialty consult or not require evaluation at a tertiary care facility. However, patients with more extensive soft tissue injury would typically require specialty consultation. Notably, it is standard practice that bony trauma to the face be seen by the plastic surgery department, which typically performs approximately 70% of all facial trauma evaluations at Rhode Island Hospital. We therefore believe our reported incidence provides reasonable insight into the burden of craniofacial injury related to electronic scooter use.

CONCLUSION

The incidence of craniofacial injury from electronic scooter use is low. However, these injuries may be significant when they do occur. Injuries most frequently take place during the summer months, occur in the afternoon or evening, and commonly involve an intoxicated operator. Like use of other motorized vehicles, rider vigilance and proper safety precautions are imperative. We advise the City of Providence to encourage best safety practices and monitoring to ensure that this shared micromobility program may continue to be effective with minimized risk for injury.

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Authors

- Luke Soliman, MTS, Division of Plastic and Reconstructive Surgery, The Warren Alpert Medical School of Brown University, Providence, RI.
- Kenny Chang, BA, Division of Plastic and Reconstructive Surgery, The Warren Alpert Medical School of Brown University, Providence, RI.
- Nicholas Sawicki, Division of Plastic and Reconstructive Surgery, The Warren Alpert Medical School of Brown University, Providence, RI.
- Nikhil Sobti, MD, Division of Plastic and Reconstructive Surgery, The Warren Alpert Medical School of Brown University, Providence, RI.
- Ronald K. Akiki, MD, Division of Plastic and Reconstructive Surgery, The Warren Alpert Medical School of Brown University, Providence, RI.
- Solomon Swartz, MD, Division of Plastic and Reconstructive Surgery, The Warren Alpert Medical School of Brown University, Providence, RI.
- Lauren O. Roussel, MD, Division of Plastic and Reconstructive Surgery, The Warren Alpert Medical School of Brown University, Providence, RI.
- Albert S. Woo, MD, Division of Plastic and Reconstructive Surgery, The Warren Alpert Medical School of Brown University, Providence, RI.

Conflicts of Interest and Source of Funding

None to declare

Correspondence

Luke Soliman, MTS
2 Dudley Street, MOC Suite 180, Providence, RI 02905
luke_soliman@brown.edu