

Assessment of Craniomaxillofacial Injuries After Electric Scooter Accidents in Turku, Finland, in 2019

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Purpose: Since the introduction of rental electric scooters (ESs), clinicians have increasingly encountered facial trauma patients whose injuries were caused by ES use. Despite this fact, few studies have analyzed these patients, particularly in Nordic countries, where the climate may cause additional challenges. We hypothesized that ESs have caused several facial trauma cases in Turku, Finland, that might be related to the timing of ES use, that is, month, day, and hour.

Patients and Methods: The medical records of all patients in whom craniofacial fractures or dental injuries caused by ES use were diagnosed at Turku University Hospital, Turku, Finland, in 2019 were reviewed. The occurrence and characteristics of injuries, with special reference to time of the accident, intoxication, hospital stay, and additional injuries sustained were analyzed.

Results: A total of 23 patients were identified for this analysis. The mean age was 30 years, and most patients (n = 16) were men. Four patients had not used helmets, whereas for 19, there was no mention whatsoever about helmet use. Of the patients, 21 were intoxicated and 18 had a blood alcohol content greater than 0.1%. A great majority of the accidents occurred in the nighttime (n = 17) and during weekends (n = 19). Most injuries (n = 15) occurred between September and November. We observed craniofacial fractures in 15 patients and dental injuries in 14; brain injuries occurred in 5 patients, and multiple chest injuries occurred in 1. All patients with dental injuries and 9 of the 15 patients with craniofacial fractures required interventions. An average of 3 days of hospitalization was required for 14 patients.

Conclusions: Injuries associated with ESs result from driving under the heavy influence of alcohol and occur mostly during weekend nights without helmet use.

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Electric scooters (ESs) have only recently become available for rent in the city of Turku, Finland, beginning in May 2019. Since the introduction of rental ESs, clinicians have increasingly encountered facial trauma patients whose injuries were caused by ES use. Turku is the sixth largest city in Finland, with 189,000 inhabitants. The population in Turku City

Center is around 55,000, and rental companies operate within a few kilometers' radius from there.

ESs (Fig 1) are regulated by the Finnish Ministry of Transport and Communications. The same traffic laws apply to both bicycles and ESs. Helmet use is regulatory but not punishable, and no traffic insurance is needed. The maximum power for ESs is 1 kW, and the

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FIGURE 1. Typical rental electric scooter used in Turku, Finland, in 2019.

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maximum speed is 25 km/hour. Driving under the influence of alcohol is forbidden but not strictly enforced unless the driver causes concrete danger to the general public. In some countries, driving these vehicles while intoxicated results in a suspension of the driver's license, but this is not the case in Finland. Alcohol has been reported as a factor in many ES accidents, but rates of intoxicated patients with ES injuries vary widely, from 4.8% in Santa Monica, California, to 36.6% in Copenhagen, Denmark.^{1,2} Most accidents happen during the late afternoon and evening hours.¹⁻⁴ Wearing a helmet reduces the risk of head injury,⁵ although helmets are rarely used.^{1-4,6,7}

ESs are used to make short trips, mostly instead of walking, bicycling, or public transportation, and they are easily available via mobile applications to rent on the go for people aged 18 years or older. This novel method of personal transportation has proliferated rapidly, and in major cities around the world, it has already led to increased numbers of facial trauma cases and even deaths, as recently described.^{1,7,8} The launch of rental ESs multiplied ES-related injuries in Auckland, New Zealand.⁷ In the United States, the National Electronic Injury Surveillance System provides national estimates of injuries related to ES use, and a dramatic increase in injuries and hospital admissions has been

reported, especially between 2017 and 2018.⁹ In Dunedin, New Zealand, a city similar to Turku in size, ES accidents were almost as prevalent as bicycle accidents in 2019.¹⁰ Patients are typically around their early thirties, and close to two thirds are male patients.^{1-3,8-10} Common injuries in ES riders are facial lacerations, fractures, head injuries, and upper- and lower-extremity injuries.^{1,2,8,11-13}

This novel patient subgroup is now encountered by maxillofacial surgeons worldwide, and we therefore aimed to present a report on ES-related craniofacial trauma encountered at our hospital. The main aim was to identify the occurrence and characteristics of craniofacial fractures and dental injuries caused by ES riding during a 1-year period.

Patients and Methods

STUDY DESIGN

To address the research aims, a retrospective cohort study was designed and implemented. From the database of Turku University Hospital, all patients who had received diagnoses of craniofacial fractures and/or dental injuries (*International Classification of Diseases, Tenth Revision* codes S02 and S03) in 2019 were identified. One of the authors (E.O.) reviewed the patient records, and patients who had sustained their injury as ES users were included.

DATA COLLECTION AND ANALYSIS

From the patient files, the following data were collected: age, gender, time and date of the injury, helmet use, presence of primary unconsciousness, transportation by ambulance to the hospital, blood or breath alcohol level, injuries sustained (ie, craniofacial fractures, dental injuries, and other injuries), length of hospitalization, and interventions required for craniofacial fractures and dental injuries. Descriptive statistics with absolute numbers and percentages were calculated and reported for all variables.

ETHICAL CONSIDERATIONS

The Internal Review Board of the Hospital District of Southwest Finland approved the study.

Results

Twenty-three patients fulfilled the inclusion criteria of having sustained their injuries as riders of ESs. **Table 1** shows patient and accident characteristics. Of the patients, 16 were men. The mean age was 30 years (range, 19 to 50 years). The great majority of accidents occurred in the night and early morning between midnight and 6 AM ($n = 17$), during weekends ($n = 19$), and in the fall between September and November ($n = 15$).

Table 1. PATIENT AND ACCIDENT CHARACTERISTICS OF 23 PATIENTS WITH ELECTRIC SCOOTER ACCIDENTS

	Average (Range)	No. of Patients	% (of 23 Patients)
Age, yr			
All	30 (19-50)	23	
Male	30 (19-50)	16	70
Female	30 (20-44)	7	30
Time of accident			
Midnight to 6 AM		17	74
Noon to 6 PM		1	4
6 PM to midnight		2	9
Unknown		3	13
Day of accident			
Monday		1	4
Tuesday		1	4
Thursday		2	9
Friday		5	22
Saturday		4	17
Sunday		10	43
Month of accident			
June		1	4
July		2	9
August		3	13
September		4	17
October		7	30
November		4	17
December		2	9
Level of intoxication			
Intoxicated		21	91
>0.20%		5	22
0.15-0.20%		6	26
0.10-0.15%		7	30
Assessed clinically		3	13
Unknown		2	9
Helmet use			
Unknown		19	83
Helmet not used		4	17
Presence of primary unconsciousness			
Yes		9	39
Transport to emergency department			
Ambulance		17	74
Ambulatory		6	26

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Twenty-one patients were under the influence of alcohol during the accident; among patients who were tested at admission, the average blood alcohol concentration was 0.17%. In the only 2 patients who did not have a measurable breath alcohol level, the diagnoses were made 1 day after the accident. Four patients had not used helmets, whereas in 19 patients, there was no mention whatsoever in the patient files about helmet use. Nine patients underwent primary unconsciousness. Seventeen patients were brought to the hospital by ambulance.

Table 2 summarizes the injuries observed. Fifteen patients sustained a total of 31 craniofacial fractures, and 14 patients were diagnosed with a total of 41 dental injuries. The most common facial fractures were isolated orbital fracture (n = 5), isolated fracture of the anterior wall of the maxillary sinus (n = 5), and condylar fracture (n = 5). Most dental injuries were fractures (n = 28). Facial soft tissue wounds were common, occurring in 21 patients. Brain injuries occurred in 5 patients and chest injuries in 1.

Table 2. INJURIES IN 23 PATIENTS WITH ELECTRIC SCOOTER ACCIDENTS

	No. of Patients	% (of 23 Patients)	No. of Injuries
Craniofacial fractures	15	65	
Mandible	6	26	
Condyle			5
Symphysis or parasymphysis			3
Body			3
Midface	10	43	
Isolated orbit			5
Maxillary sinus			5
Nose			3
Frontal bone			2
Le Fort I-III			1
Hard palate			1
Zygomatico-orbital			1
Skull base	2	9	
Frontal skull base			2
Dental injuries	14	61	
Dental fracture			28
Ligament injury			13
Other facial injuries	21	91	
Soft tissue wound			21
Orbital extraconal hematoma			1
Brain injuries	5	22	
Diffuse axonal brain injury			3
Contusion			2
Subarachnoid hemorrhage			2
Traumatic subdural hemorrhage			1
Concussion			1
Chest injuries	1	4	
Lung contusion			1
Multiple rib fractures			1

Note: A proportion of patients presented with multiple injuries; thus, the injury number is higher than that of the patients (N = 23). Percentages are computed from all patients (N = 23).

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Fourteen patients required an average of 3 days of hospitalization. Of these patients, 6 required less than 24 hours of observation, whereas 4 needed 24 to 72 hours and 4 needed more than 72 hours of hospitalization.

All 14 patients with dental injuries and 16 of the 21 patients with facial wounds required interventions. Table 3 summarizes interventions required in the 15 patients who had sustained craniofacial fractures. The most common procedures were surgical treatment of mandibular fractures (n = 4) and surgical treatment of orbital fractures (n = 2).

Discussion

The aim of this study was to identify the occurrence and characteristics of craniofacial fractures and dental injuries caused by ES riding during a 1-year period. We

observed that most accidents occurred in the nighttime during weekends and were associated with heavy alcohol use. In recent studies from Copenhagen and Los Angeles, 33.9% and 18% of accidents occurred between 11 PM and 7 AM; in comparison, in our cohort, 74% occurred between midnight and 6 AM.^{1,2} Surprisingly, most of the accidents happened during late autumn rather than in summer, as reported in Copenhagen and as compared with Finnish bicycle-related maxillofacial fractures.¹⁴ ES rental companies arrived in Turku in May 2019, explaining the lack of accidents between January and May. As the adoption of scooters into popular use might take time, the probability of ES accidents during summer may be underestimated because information about the number of rental ESs during the launch and changes in volume during 2019 were not provided for our analysis. Additional

Table 3. INTERVENTIONS FOR CRANIOFACIAL FRACTURES IN 15 OF 23 PATIENTS WITH ELECTRIC SCOOTER ACCIDENTS

	No. of Patients	% of 15 Patients
Open reduction and internal fixation of mandibular fracture	4	27
Reconstruction of orbital wall	2	13
Open reduction and fixation of maxillary fracture	1	7
Close reduction of nasal bone fracture	1	7
Lateral canthotomy due to elevated intraorbital pressure	1	7

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information on ESs regarding frequency of use and use in different seasons was requested from ES companies operating in Turku, but no responses were received. Exceptionally long periods of daylight, up to more than 23 hours of daylight or civil twilight in summer in southern Finland, also might help lower the risk of accidents during nighttime and may partly explain the higher occurrence of accidents in autumn compared with summer.

Although our study population is small, several injuries and patient characteristics were similar to those published previously. Patients who experience these injuries are young adults with a male preponderance, likely heading home from nightclubs or bars during the early morning hours. This is in accordance with previous results from Dallas, Texas,³ although this has not been reported consistently in the literature,² likely reflecting differences in young adult culture, ES adoption frequency, and alcohol use patterns.

Our study population presented with a high alcohol intoxication prevalence: 91% of patients were intoxicated, and the measured average ethanol level was 0.17% in 18 patients. These numbers are high compared with the values described in other studies: 4.8% of patients with ES injuries in Los Angeles, California,² 17.8% in Dallas, Texas,³ 28% in Brisbane, Queensland, Australia,⁴ and 36.6% in Copenhagen, Denmark,¹ were intoxicated. This finding may signify that ethanol abuse predisposes patients to maxillofacial injuries in particular, as these studies also included patients with injuries other than craniomaxillofacial injuries in relation to ES use.

A recent study from Copenhagen reported that only 44.6% of patients with ES-related injuries needed suturing, whereas 70% of our patients did.¹ This difference likely results from a lower prevalence of intoxication, as stated earlier. Trivedi et al³ proposed that the high prevalence of injuries to the extremities found in their study resulted from patients breaking their fall during a crash. In our study, however, no extremity injuries were detected in patients with craniofacial or dental injuries. Again, this difference likely

results from the high number of intoxicated patients in our cohort compared with those observed by Trivedi et al (91% vs 18%), likely suggesting that intoxication leads to diminished capacity to break one's fall with the hands. This result also contrasts with typical maxillofacial fracture-associated injury patterns from earlier Finnish data, in which 11.5% of bicyclists presented with extremity injuries as well.¹⁵ Instead, many patients experienced multiple dental fractures and facial lacerations. Severe head injuries involving the intracranial structures also were present, and despite the low number of patients involved, the prevalence of substantial brain injuries can be considered high (22%). All these findings combined suggest that the setting and time of ES use lead to different injury patterns and suggest preventive possibilities, as most injuries present in the nighttime, on weekends, and under the influence of ethanol.

Our findings may be used to inform decision makers concerning ES use and how it is regulated, especially for nighttime use during weekends. Driving under the influence of alcohol would most likely decrease substantially if ESs were unavailable during nighttime, and further open discussion between rental companies and health care providers could prove helpful for reducing ES-related risks in the future. Helmet use should be further promoted, as most studies report their use as very rare.^{1-4,6,7} In this study, only 4 patients had a mention of no helmet use in their patient records. All the other trauma patients had no mention whatsoever of helmet use. In our estimation, helmets likely were not worn by any of these patients as the vast majority of injuries happened during nighttime and under the influence of alcohol. Our personal observation is that helmets are a rare sight among ES users on the streets of Turku even during the daytime. Therefore, more studies about ES accidents are needed, and in the future, it will be important to specifically compare ES accidents with bicycle accidents to determine the relative risks involved in these increasingly important modes of personal transportation.

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