SCIENTIFIC LETTERS

Electric scooter accidents and injuries

El patinete eléctrico: accidentes y lesiones derivadas de su uso

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Recent years have seen changes in mobility that are transforming intra-urban travel. The combination of comfort, sustainability and the use of new technologies has given rise to new forms of transportation, the so-called personal mobility vehicles (PMVs),[1] among which e-scooters (ES) stand out. The increase in its use has been accompanied by an increase in the number of accidents and secondary injuries, with a wide range of severity.[2-5] These accidents are a social and health problem to be studied, have aroused the interest of the media and have even generated changes in Spanish legislation, regulating its use (speed, helmet use, roads).[1] The primary objective of this project was to analyze the injuries associated with the use of ES in patients attended in the emergency department (ED) of Hospital 12 de Octubre in Madrid, a tertiary hospital. Secondary objectives were to analyze demographic differences, temporal patterns and risk behaviors during use.

A descriptive, retrospective study was conducted on patients over 18 years of age who attended the ED and the Trauma and Emergency (T&E) Intensive Care Unit (ICU) due to an accident with ES, between January 2018 and January 2022. Pedestrians hit by ES, those produced by other vehicles and pregnant women were excluded, because they were attended in a different ED (Figure 1). Sociodemographic data, prehospital and hospital care, mechanism of injury, and driving risk behaviors were collected, as well as data on the type of injury and its anatomical location. Severity was estimated according to the Abbreviated Injury Scale (AIS) and the Injury Severity Score (ISS).[6] The data were analyzed using SPSS program version 25. Categorical data were presented as frequencies and percentages. Means with standard deviation were calculated for normally distributed data and medians and interquartile ranges for non-normally distributed data. Comparison between groups was performed with the chi-square test. The statistical significance level was set at $P < 0.05$. The study was approved by the Research Commission of the Instituto de Investigación Hospital 12 de Octubre (Registration TP22/0078).

We analyzed the clinical and sociodemographic variables of a total of 198 patients, 138 men (69.7%), aged between 18 and 62 years, with a mean of 32 years (Table 1). Most of the injured were evaluated in the ED (83.8%). Fourteen (7.1%) were admitted directly to the T&E ICU, and the rest (9.1%) were assessed as potentially serious by the T&E ICU without being admitted to its unit. One third of the total number of injuries (36.3%), including all serious traumas, received prehospital care and transfer to hospital. Fifteen percent required hospital admission and no deaths were recorded.

The most frequent mechanism of injury was a fall (76.8%), followed by being run over by another vehicle (14.1%), collision with another object (5%) and collision with the structure of the scooter (4%). A total of 375 injuries were identified, 109 simple fractures or fractures accompanied by other injuries (Table 2). Injuries at different levels were observed in more than half (58.6%). The upper limb was the most injured anatomical region, totalling 113 injuries (30.1% of the total) with 50 fractures, and the radius was the most affected bone (24 fractures), followed by the scaphoid (6 cases). In the lower limb, 76 injuries were observed (20.2%) with 13 fractures, and the tibia was the most fractured bone (8 cases). Traumatic brain injury (TBI) was observed in 63 patients (31.8%), 10 of them associated with intracranial hemorrhage or bone fracture and 22 patients (11.1%) had TBI and facial trauma simultaneously. Orthopedic radiography was the most frequently performed radiological test, specifically that of the upper limb (40.4% of patients).

Of the 375 total injuries, 80 injuries were classified with an AIS between 2 and 5. 68 patients (34.3%) had at least one moderate-severe injury. Within the subgroup of patients with severe trauma, the most severe injury observed was TBI (82%) and in the remaining 18%, severe abdominal trauma was the most common. In these patients, the mechanisms of injury were accidental fall (63%), run over by another vehicle (27%) and in one patient, collision with a fixed object.

Among the risk behaviors observed, of the 63 patients with TBI,

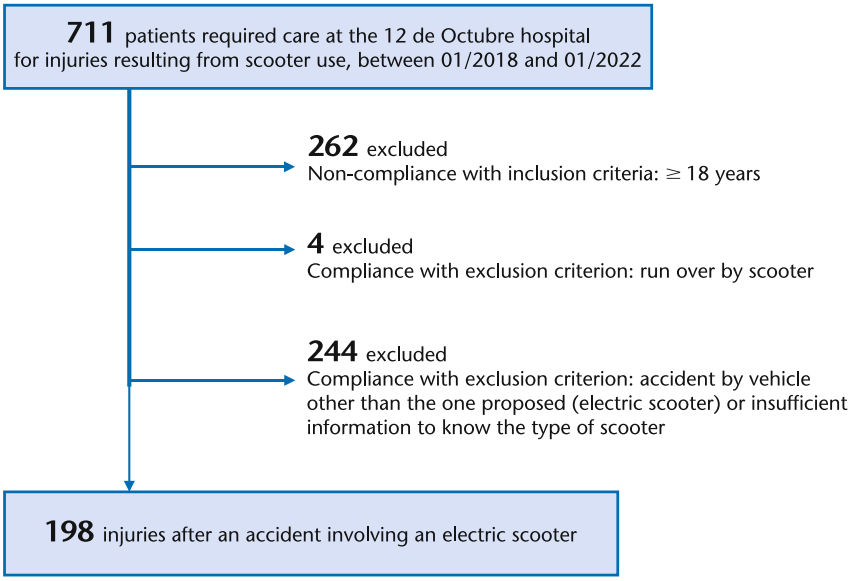

Figure 1. Obtaining the final sample after applying the inclusion and exclusion criteria.

Table 1. Clinical and demographic variables

	All patients			Severe trauma patients
	Total N = 198 n (%)	Men N = 138 n (%)	Women N = 60 n (%)	Total N = 11 n (%)
Demographic variables				
Age				
18-35 years	133 (67.2)	92 (66.7)	41 (68.3)	5 (45.5)
36-50 years	50 (25.3)	35 (25.3)	15 (25)	5 (45.5)
51-64 years	15 (7.5)	11 (8)	4 (6.7)	1 (9)
Time trends				
Time of day				
7 am-3 pm	55 (28.1)	40 (29)	15 (25)	3 (27.3)
3 pm-11 pm	100 (50.5)	63 (45.7)	37 (61.7)	6 (54.5)
11 pm-7 am	43 (21.9)	35 (25.3)	8 (13.3)	2 (18.2)
Day of the week				
Friday	38 (19)	27 (19.7)	11 (18.3)	5 (45.5)
Season of the year				
Winter	30 (15.1)	23 (16.7)	7 (11.7)	3 (27.3)
Spring	37 (18.8)	25 (18.1)	12 (20)	2 (18.2)
Summer	67 (33.8)	46 (33.3)	21 (35)	4 (36.3)
Autumn	64 (32.3)	44 (31.9)	20 (33.3)	2 (18.2)
Care variables				
Prehospital care				
Yes	72 (36.3)	48 (34.7)	24 (40)	11 (100)
No	126 (63.7)	90 (65.3)	36 (60)	0 (0)
Hospital care				
Emergency department	166 (83.8)	114 (82.7)	52 (86.7)	0 (0)
Trauma and Emergency Units short-stay	18 (9.1)	15 (10.8)	3 (5)	0 (0)
Admission to Trauma and Emergency Units	14 (7.1)	9 (6.5)	5 (8.3)	11 (100)
Injury mechanism				
Fall	152 (76.8)	106 (76.9)	46 (76.7)	7 (42.8)
Hit by vehicle	28 (14.1)	20 (14.6)	8 (13.3)	3 (14.2)
Collision against object	10 (5.1)	7 (5)	3 (5)	1 (7.1)
Hit by Electric scooter	6 (3)	3 (2.1)	3 (5)	0 (0)
Uncertain	2 (1)	2 (1.4)	0 (0)	0 (0)
Discharge destination				
Admission	30 (15)	20 (14.5)	10 (16.7)	11 (100)
Home	168 (85)	118 (85.5)	50 (83.3)	0 (0)
Risk behaviors				
Helmet wearing				
Unknown	143 (7.2)	99 (71.7)	44 (73.3)	0 (0)
Yes	41(30.8)	10 (7.3)	4 (6.7)	2 (18.2)
No	14 (7.1)	29 (21)	12 (20)	9 (81.8)
Speed				
Unknown	137 (69.2)	126 (91.4)	58 (96.7)	5 (45.5)
< 25 km/h	46 (23.2)	6 (4.3)	0 (0)	4 (36.3)
> 25 km/h	15 (7.6)	6 (4.3)	2 (3.3)	2 (18.2)
Alcohol consumption				
Unknown	184 (92.9)	90 (65.2)	46 (76.7)	9 (81.8)
Yes	6 (3)	37 (26.8)	10 (16.6)	0 (0)
No	8 (4)	11 (8)	4 (6.7)	2 (18.2)
Technical variables				
No imaging test	35 (17.6)	21 (15.2)	14 (23.3)	0 (0)
X-ray				
Chest	34 (17.1)	26 (18.8)	8 (13.3)	0 (0)
Upper limb	80 (40.4)	62 (44.9)	18 (30)	3 (14.2)
Lower limb	47 (23.7)	30 (21.7)	17 (28.3)	0 (0)
Computed tomography				
Cranial	43 (21.7)	30 (21.7)	13 (21.7)	10 (91)
Holo-corporeal	15 (7.5)	10 (7.2)	5 (8.3)	9 (81.8)

26 did not wear helmets compared to 3 patients who said they were wearing helmets. Of the total number of patients without TBI, 15 admitted not wearing helmets compared to 11 who did. A statistically significant relationship was demonstrated between helmet absence and TBI in any severity range ($P < .05$).

This study shows a progressive increase in the number of visits to the emergency department from 2018 to 2021, as in other European cities.[4,5,7-9] In line with what has been raised in other studies,[2-9] the most frequent user of ES is the young male and a higher incidence of accidents is observed in summer, on Fridays and in the late afternoon.

As an injury pattern, the proximal upper limb (elbow) predominates, followed by the lower limb (knee) and the skull.[2,4,5,7-10] It is noteworthy that the mechanism of injury differs from that described with other unipersonal vehicles such as skateboards, where distal limb involvement is typically described.[10] This may be related to the greater speed reached at the time of the accident and the short distance from the ES to the ground, with the consequent decrease in reaction time. This same circumstance would explain why up to one-third of the injured patients preexperienced TBI.[10]

In agreement with other authors,[4,5,8,9] we consider that ES accidents should be managed as high-energy trauma, and partial or complete activation of trauma teams may be necessary, given the high rate of care by the ICU (16%), severe trauma (1 out of every 20 patients) and moderate-severe injury (AIS $\geq$ 2) recorded, as shown in Table 2. It would be necessary to review current legislation and insist on educational measures aimed at the users of these vehicles, given the risks to which they are exposed without adequate protective measures.

Victims of ES accidents present an atypical injury pattern, with the upper limb being the most affected, more proximal to other single-vehicle vehicles. There is a very wide range of injuries, with one third of cases being moderate or severe. The profile of the ES user is a young male and emergency care is predominantly provided in the late afternoon, on Fridays and during the summer months. Regarding helmets, we observed a clear relationship between the absence of helmets and TBI, so it

Table 2. Abbreviated Injury Scale (AIS) score of lesions according to anatomic location in the 198 cases.

Injuries	N	Fracture	N	AIS score*	
Location	n (%)	Bone	n (%)	Location	n (%)
Skull		**Skull**		**Skull**	
Contusion and injury	53 (26.7)	Temporary	4 (2.0)	AIS 0	135 (68.2)
Bone fracture and bleeding**	8 (4.0)	Parietal	3 (1.5)	AIS 1	53 (26.8)
Bleeding without fracture	2 (1.0)	Frontal	2 (1.0)	AIS 3	6 (3)
		Skull base	1 (0.5)	AIS 4	1 (0.5)
		Crag	1 (0.5)	AIS 5	3 (1.5)
Face		**Face**		**Cara**	
Contusion and wound	38 (19)	Zygoma	6 (3.0)	AIS 0	145 (73.2)
Single fracture	9 (4.5)	Nose	6 (3.0)	AIS 1	41 (20.7)
Multiple fracture	6 (3.0)	Mandible	6 (3.0)	AIS 2	10 (5.1)
Nerve injury (III cranial nerve)	1 (0.5)	Dental-dentoalveolar	9 (4.5)	AIS 3	2 (1)
Thorax		**Thorax**		**Thorax**	
Contusion and wound	24 (12.1)	Rib	11 (5.6)	AIS 0	169 (85.4)
Single bone fracture	2 (1.0)			AIS 1	27 (13.6)
Multiple bone fracture	2 (1.0)			AIS 2	1 (0.5)
Pulmonary contusion	2 (1.0)			AIS 4	1 (0.5)
Vertebral		**Vertebral**		**Vertebral**	
Contusion and injury	10 (5.1)	Dorsal	1 (0.5)	AIS 0	168 (84.8)
Bone fracture	2 (1.0)	Lumbar	1 (0.5)	AIS 1	28 (14.1)
				AIS 2	1 (0.5)
				AIS 3	1 (0.5)
Abdomen		**Abdomen**		**Abdomen**	
Contusion and wound	2 (1.0)			AIS 0	191 (96.5)
Solid organ injury	4 (2.0)			AIS 1	3 (1.5)
Contusion/hepatic hematoma	3 (1.5)			AIS 2	1 (0.5)
Renal contusion/hematoma	2 (1.0)			AIS 4	3 (1.5)
Adrenal contusion/hematoma	1 (0.5)				
Upper limb		**Upper limb**		**Upper limb**	
Contusion and injury	65 (33)	Radius	24 (12.1)	AIS 0	90 (45.5)
Single fracture	32 (16)	Scaphoid	6 (3.0)	AIS 1	68 (34.3)
Multiple fracture	8 (4.0)	Ulna	5 (2.5)	AIS 2	37 (18.7)
Open fracture	3 (1.5)	Ulnar radius	3 (1.5)	AIS 3	3 (1.5)
Dislocation		Clavicle	5 (2.5)		
Acromioclavicular dislocation	2 (1.0)	Phalange	4 (2.0)		
Glenohumeral dislocation	2 (1.0)	Humerus	4 (2.0)		
Elbow dislocation	1 (0.5)	Scapula	2 (1.0)		
Lower limb		**Lower limb**		**Lower limb**	
Contusion and injury	66 (33.3)	Tibia	8 (4.0)	AIS 0	122 (61.6)
Single fracture	7 (3.5)	Fibula	4 (2.0)	AIS 1	66 (33.3)
Multiple fracture	3 (1.5)	Femur	1 (0.5)	AIS 2	7 (3.5)

*AIS[6] scale. AIS 1: minor injury, AIS 2: moderate injury, AIS 3: severe injury, AIS 4: severe life-threatening injury, AIS 5: critical injury, AIS 6: non-surviving injury.
**Intracranial bleeds include epidural hematoma (4), subdural hematoma (4), subarachnoid hemorrhage (6) and intrapa-renchymal hematomas (5). In two out of three head injuries with intracranial bleeding, several types of concomitant bleeding were observed.
***Note that 40 of the 198 patients (20.2%) had at least one moderate-severe injury (AIS ≥ 2) of the upper limb.

seems reasonable to make their use mandatory.

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