



E-bike-related cranial injuries in pediatric population

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Abstract

Purpose E-bikes are being used increasingly by all age groups. Children riding e-bikes often do not use safety equipment such as helmets, and are at increased risk for injuries requiring neurosurgery. The most common type of injury among pediatric e-bikers is head and neck trauma. We describe our experience treating cranial injuries.

Methods Data regarding children (< 18 years old) with e-bike-related cranial injuries were collected retrospectively from two tertiary centers.

Results Twenty patients were included. Seventeen were e-bike users, and three were hit as pedestrians. The average age at admission was 11.3 ± 4.85 (range 1.5–17) years old. All 17 e-bike users did not wear a helmet. Seventeen of the 20 (85%) suffered from skull fractures (70% involving the frontal bone), nine involving more than one region. Six patients (30%) had intracerebral contusions, 3 (15%) an epidural hematoma, and 6 (30%) a subdural hematoma. Three patients (15%) underwent surgery, two of them for depressed skull fracture reduction, and one for insertion of intracranial pressure monitor. One patient died (5%); 1 (5%) had a Glasgow Outcome Scale (GOS) of 3, 5 (25%) had a GOS of 2, and 13 (65%) were discharged without any neurological deficit (GOS 1).

Conclusion E-bikes may inflict various cranial injuries, including fractures and intracranial bleeds, and may lead to significant morbidity and mortality. Education of children to use protective gear, wide exposure of younger adolescents to traffic laws, and limiting the use of e-bikes to older children, are all necessary actions.

Keywords E-bikes · Neurosurgery · Head injury · Helmet · Children

Introduction

Electrical bicycles and scooters (e-bikes) are widely used light electrical vehicles that provide a convenient and attractive type of city transportation [2, 3, 5, 6, 11–13, 15]. Currently, e-bikes are the most widely used electrical transportation in the world. There is no world-wide unified legislation regarding e-bikes, nothing defining age limits nor any type of e-bike power and speed limitations.

E-bike-related injuries leading to morbidity and mortality, both to the direct users and also to pedestrians, have

been described recently in adults and children [2, 3, 5, 11, 13, 15]. Recent literature states that pediatric population constitute 35% of overall e-bike trauma, leading mostly to head and neck injuries, perhaps because of their higher head-to-body size and weight ratio [2, 5, 6]. In comparison to regular bicyclists, e-bikers have been found to have more accidents (falls from e-bike, collisions with static objects), at higher velocities and collision speeds [5, 15]. These studies suggest that e-bike-related trauma may involve more serious injuries and have injury patterns that resemble those seen in motorcycle-related injuries, compared to the injuries of regular bicyclists.

The use of e-bikes in Israel has escalated over recent years [5], often by children and teenagers, without sufficient education regarding traffic laws or other licensing requirements. These users often do not respect traffic laws, and do not use personal protective gears (e.g., helmets). The aim of this study is to evaluate e-bike-related cranial injuries in pediatric population with an emphasis on location and type of injury, need for surgical treatment, and outcomes.

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Methods

Following an institutional review board (IRB) approval, data was collected retrospectively, including all e-bike-related cranial injuries admitted to Department of Pediatric Neurosurgery at Dana Children's Hospital, Tel-Aviv Medical Center, in Tel-Aviv, Israel, between January 2011 and January 2019. Similar cases admitted during 2018 to the Pediatric Neurosurgery Unit at Rambam Health Campus, in Haifa, Israel were also included. All patients included in the study were < 18 years old at the time of admission. The collected data-base consisted of demographics, mechanism of injury (including whether the patient was the rider, mounted on, or injured as a pedestrian), other accompanying body injuries, use of helmet, Glasgow-Coma Scale (GCS) at admission, underlying neurosurgical injury, cranial/cervical imaging findings, days in intensive care unit (ICU), neurosurgical interventions, duration of hospital stay (DOS), and neurological outcome. Motorcycle and non-e-bike injuries were excluded from the study.

Head trauma without radiological findings were excluded, as well as patients with missing clinical or radiological data regarding mechanism of accident, clinical course, or radiological findings at presentation.

Data was extracted from personal folders and follow-up notes, and imaging data was retrieved from the PACS systems. Patient and family consents were waived by the IRB.

Data analysis

As the number of participants was small, data was presented in a descriptive manner, and only basic statistics were done (mean \pm standard deviation).

Fig. 1 Illustration of an e-bike-related accident. The child is not using a helmet



Results

Twenty e-bike-related cranial trauma patients were included (18 from Tel-Aviv, and 2 from Haifa). Seventeen were e-bike users, and three were pedestrians hit by e-bikes. All 17 e-bike users did not wear a helmet (Fig. 1). Fifteen were male (75%). Twelve patients (70.6%) were the main e-bike riders (ages 10–15 years old, 14 ± 1.6), five patients (29.4%) were mounted on e-bike (ages 1.5–17 years old), and three were injured as pedestrians (ages 5–8 years old).

Three dominant mechanisms of injury were identified: 9 (45%) fell off the bike, 8 (40%) collided with another vehicle, and 3 (15%) were pedestrians hit by an e-bike.

Several traumatic pathologies were identified: 17 of the 20 patients (85%) suffered from one or multiple skull fractures, (12 (70.6%) frontal, 5 (29.4%) temporal, 5 (29.4%) parietal, 2 (11.8%) occipital, and 2 (11.8%) skull base fractures). Nine patients had fractures involving more than one region. Six patients (30%) had intracerebral contusions, 3 (15%) an epidural hematoma, and 6 (30%) a subdural hematoma. Seven (35%) patients suffered a right-sided injury, 5 (25%) left sided, and 8 (40%) suffered from a bilateral injury.

Average Glasgow Coma Scale (GCS) at admission was 13.15 ± 3.7 (11–15, except one patient who arrived at GCS3). The patients were hospitalized for an average of 5.5 (range 2–22) days, 1.85 days in ICU. Ten patients (50%) had multi-trauma injury, mostly involving limbs. Three patients (15%) underwent surgery, two of them for depressed skull fracture reduction, and one underwent insertion of intracranial pressure (ICP) monitor.

Glasgow Outcome Score (GOS) at discharge was 1.55 ± 1 . One patient (who presented with GCS 3) died (5%), 5 (25%) had a GOS of 2, 1 (5%) had a GOS of 3, and 13 (65%) were discharge without any neurological deficit (GOS 1).

Discussion

This study is the first to describe cranial injuries among children using e-bikes. None of these children wore helmets. Injuries included fractures and intracranial bleeds of various locations and sizes. There was associated morbidity and mortality. Some of the children underwent surgery. Although we could not estimate the total number of e-bike users, the unacceptable reality of careless use of this transportation system leads to injuries, warranting educational and legislative concern.

E-bikes are being used increasingly worldwide [2, 3, 6, 11–13, 15]. They are a convenient and relatively cheap form of transportation, environmental friendly, combining the handiness of a bicycle with an electrical engine. However, e-bikes may have several negative impacts:

- (1). Although their use does improve physiological parameters [1, 7], e-bikes involve less physiologic activity compared to regular (non-e) bikes [14]. This has great importance at any age, but especially during adolescence.
- (2). Many countries do not have dedicated riding paths for e-bikes. Thus, their use on regular roads may lead to e-bike-vehicle conflicts, while their use on dedicated regular bicycle paths may lead to e-bike-regular bicycle conflicts [5].
- (3). Secondary to their increased speed, there is an increased potential for injury following collision between the e-bike rider and a pedestrian, or following a fall from the e-bike. Compared to non-e-bikes, trauma with an e-bike is more likely to require admission to the emergency room, despite similar rates of hospital admission for medical observation and treatment [12].
- (4). Many users, especially young ones, underestimate the danger of e-bikes, compared to traditional bicycles.
- (5). Various countries have different laws regarding the need for safety gear during bicycle riding (e.g., use of a helmet). These laws are not necessarily sufficient for e-bike riders.
- (6). Despite e-bike riders often riding on roads, there are no regulations regarding licensing of this vehicle, and similar to non-e-bikes, many of the e-bike riders violate traffic signals [8].

Adolescents and children using e-bikes might be at increased risk, due to the lack of knowledge of traffic laws, immature and irresponsible judgment, and physiological

differences compared to adults. Thus, it is extremely important to stress the potential risks, especially among this age group.

Our results reflect the risks of e-bikes in the pediatric age group [5, 6]. Most of our patients were in the mid-teen age group, and none of them had used a helmet at the time of the accident. The results of this study highlight the potential need for surgical treatment, as well as required admission time in ICU and regular departments, reflecting the financial toll of these injuries.

Our data shows a relatively high rate of so called “single” injury mechanism, with falling off the e-bike, or collision with static objects, at much higher rates than stated in literature for regular non-e-bike riders, making this pattern of injury similar to motorcycle riders injuries.

Limitations

Our data is limited to patients admitted with cranial findings on imaging. We could not include other e-bike-related injuries, patients not transferred to medical care, and patients that were found dead at the scene. Also, we could not assess the impact that the use of helmets has on injury patterns. Thus, our data is biased to patients not using helmets. However, a recent publication from our center, including all pediatric emergency department admissions of e-bike injuries, stated that only 19% of all e-bike-related pediatric traumas involved use of a helmet [6]. In light of the added value of helmets in reducing brain injuries related to non-e-bikes [4, 10], and to motorcyclists [9], it is simply logical to deduce its value in e-bike use.

Conclusions

E-bikes may inflict various cranial injuries, including fractures and intracranial bleeds, and may lead to significant morbidity and mortality. Education to use protective gear, wide exposure of younger adolescence to traffic laws, and limiting the use of e-bikes to older children, are reasonable recommendations.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

References

1. de Geus B, Kempenaers F, Lataire P, Meeusen R (2013) Influence of electrically assisted cycling on physiological parameters in untrained subjects. *Eur J Sport Sci* 13:290–294
2. Du W, Yang J, Powis B, Zheng X, Ozanne-Smith J, Bilston L, He J, Ma T, Wang X, Wu M (2014) Epidemiological profile of hospitalised injuries among electric bicycle riders admitted to a rural hospital in Suzhou: a cross-sectional study. *Inj Prev* 20:128–133
3. Feng Z, Raghuwanshi RP, Xu Z, Huang D, Zhang C, Jin T (2010) Electric-bicycle-related injury: a rising traffic injury burden in China. *Inj Prev* 16:417–419
4. Ganti L, Bodhit AN, Daneshvar Y, Patel PS, Pulvino C, Hatchitt K, Hoelle RM, Peters KR, Kuchibhotla S, Lottenberg L, Gabrielli A, Mazzuocolo A, Elie-Turenne MC, Falgiani T, Maerz PW, Kharod SM, Conroy LM, Khalid HM, Tyndall JA (2013) Impact of helmet use in traumatic brain injuries associated with recreational vehicles. *Adv Prev Med* 2013:450195
5. Gross I, Weiss DJ, Eliasi E, Bala M, Hashavya S (2018) E-bike-related trauma in children and adults. *J Emerg Med* 54:793–798
6. Hermon K, Capua T, Glatstein M, Scolnik D, Tavor O, Rimon A (2018) Pediatric electric bicycle injuries: the experience of a large urban tertiary care pediatric hospital. *Pediatr Emerg Care*:1
7. Hoj TH, Bramwell JJ, Lister C, Grant E, Crookston BT, Hall C, West JH (2018) Increasing active transportation through e-bike use: pilot study comparing the health benefits, attitudes, and beliefs surrounding e-bikes and conventional bikes. *JMIR Public Health Surveill* 4:e10461
8. Langford BC, Chen J, Cherry CR (2015) Risky riding: naturalistic methods comparing safety behavior from conventional bicycle riders and electric bike riders. *Accid Anal Prev* 82:220–226
9. Liu BC, Ivers R, Norton R, Boufous S, Blows S, Lo SK (2008) Helmets for preventing injury in motorcycle riders. *Cochrane Database Syst Rev* Cd004333
10. Olivier J, Creighton P (2017) Bicycle injuries and helmet use: a systematic review and meta-analysis. *Int J Epidemiol* 46:372
11. Papoutsi S, Martinolli L, Braun CT, Exadaktylos AK (2014) E-bike injuries: experience from an urban emergency department—a retrospective study from Switzerland. *Emerg Med Int* 2014:850236
12. Schepers JP, Fishman E, den Hertog P, Wolt KK, Schwab AL (2014) The safety of electrically assisted bicycles compared to classic bicycles. *Accid Anal Prev* 73:174–180
13. Tenenbaum S, Weltsch D, Bariteau JT, Givon A, Peleg K, Thein R (2017) Orthopaedic injuries among electric bicycle users. *Injury* 48:2140–2144
14. Theurel J, Theurel A, Lepers R (2012) Physiological and cognitive responses when riding an electrically assisted bicycle versus a classical bicycle. *Ergonomics* 55:773–781
15. Weber T, Scaramuzza G, Schmitt KU (2014) Evaluation of e-bike accidents in Switzerland. *Accid Anal Prev* 73:47–52

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