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Bicycle helmets work when it matters the most

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Abstract

BACKGROUND: Helmets are known to reduce the incidence of traumatic brain injury (TBI) after bicycle-related accidents. The aim of this study was to assess the association of helmets with severity of TBI and facial fractures after bicycle-related accidents.

METHODS: We performed an analysis of the 2012 National Trauma Data Bank abstracted information of all patients with an intracranial hemorrhage after bicycle-related accidents. Regression analysis was also performed.

RESULTS: A total of 6,267 patients were included. About 25.1% (n = 1,573) of bicycle riders were helmeted. Overall, 52.4% (n = 3,284) of the patients had severe TBI, and the mortality rate was 2.8% (n = 176). Helmeted bicycle riders had 51% reduced odds of severe TBI (odds ratio [OR] .49, 95% confidence interval [CI] .43 to .55, $P < .001$) and 44% reduced odds of mortality (OR .56, 95% CI .34 to .78, $P = .010$). Helmet use also reduced the odds of facial fractures by 31% (OR .69, 95% CI .58 to .81, $P < .001$).

CONCLUSION: Bicycle helmet use provides protection against severe TBI, reduces facial fractures, and saves lives even after sustaining an intracranial hemorrhage.

Over the last few years, bicycle riding has become one of the most popular outdoor activities in the United States.[1] Approximately 67 million bicyclists ride across the United States accounting for about 15 billion hours of cycling per year.[2] Despite being a healthy sport and recreational activity, it comes with its own hazards. In the year 2013, there were 900 deaths and estimated 494,000 emergency department (ED) visits due to bicycle-related injuries.[3] Traumatic brain injury (TBI), maxillofacial trauma, and dental injuries are not uncommon in bicycle riders. TBI is the leading cause of morbidity and mortality after bicycle-related injuries, comprising one third of ED visits, two thirds of hospital admissions, and three quarters of deaths.[4] The US healthcare department spends over $2 billion on bicycle-related TBI annually.[5]

Helmet use in bicycle riders is considered protective because of its inherent sense and logic. For this reason, many state governments have also established legislations regarding mandatory use of helmets to counter the rising

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trends of bicycle-related injuries and mortality. Several studies have looked at the efficacy of helmet use for bicycle riders and have shown its protective role against TBI.[1,6–11] However, limited data exist regarding the role of helmets in reducing the severity of TBI particularly in patients with an intracranial injury following a bicycle-related accident. The use of helmets in motorcycle riders has also shown to be protective against facial fractures; however, the protective role of helmets against facial fractures in bicycle riders is unclear.[12]

We aimed to assess the association of helmets with severity of TBI and facial fractures in patients with intracranial head bleeds after bicycle-related accidents using the National Trauma Data Bank (NTDB). We hypothesized that bicycle helmet use in patients with an intracranial head bleed is associated with reduced severity of injury and facial fractures.

Patients and Methods

We performed a 1-year (2012) retrospective study of the National Trauma Data Bank (NTDB). The NTDB is the largest collection of trauma cases, which is maintained by the American College of Surgeons (Chicago, IL). The NTDB contains more than 1.8 million patients, which is contributed by over 900 trauma centers across United States. We included all trauma patients involved in a bicycle-related accident and a diagnosis of intracranial hemorrhage. Transferred patients and patients who arrived with no vital signs were excluded.

Cases of bicycle-related accidents were identified through an electronic search of all International Classification of Diseases, Ninth Revision external cause of injury codes for bicycle-related accidents in the NTDB (E801.3, E805.3, E810.6 to E825.6, E826.1). The following International Classification of Diseases, Ninth Revision diagnosis codes were used to identify the intracranial hemorrhages and the facial fractures: cerebral laceration and contusion (851.0 to 851.9); subarachnoid, subdural, and extradural hemorrhage (852.0 to 852.5); other unspecified intracranial hemorrhage following injury (853.0 to 853.1); intracranial injury of other unspecified nature (854.0 to 854.1); skull fracture with intracranial injury (800.1 to 800.9); fracture of base of skull with intracranial injury (801.1 to 801.9); other unqualified skull fractures with intracranial injury (803.1 to 803.9); multiple fractures of skull or face with other bones and intracranial injury (804.1 to 804.9); orbital wall fractures (802.6, 802.7, and 802.8); nasal fractures (802.0 and 802.1); malar fractures (802.4 and 802.5); mandibular fractures (802.20 to 802.39); and contusions of face, scalp, and orbital area (802.0, 802.1, 920, 921.1, 921.2, 921.3, and 921.9).

The following data points were extracted for each patient: age, sex, race, insurance status, Injury Severity Scale (ISS) score, head-Abbreviated Injury Score (h-AIS), ED systolic blood pressure (SBP), ED heart rate, ED Glasgow Coma Scale (GCS) score, helmet use, craniotomy, and mortality. Patients were divided into 2 groups based on the use of helmets: helmeted and nonhelmeted. To determine the frequency of helmet use across age groups, we divided our population into 8 groups: less than or equal to 10, 11 to 20, 21 to 30, 31 to 40, 41 to 50, 51 to 60, 61 to 70, and greater than 70 years.

Our outcome measures were the following: severe TBI, mortality, craniotomy, any facial fracture, mandibular fracture, malar fracture, orbital wall fracture, nasal fracture, and contusions/lacerations of the face, scalp, and orbital area. Severe TBI was defined by an h-AIS score of 4 and above.

Statistical analysis

Missing data for ED SBP, insurance, ED GCS, ISS, and h-AIS were treated as missing at random and multiple imputations were performed to account for the missing values. This technique is implemented to reduce the bias and increase the number of available cases.[13] To impute the datasets, the original dataset was analyzed using Little's missing completely at random test. The procedure for multiple imputations was Markov Chain Monte Carlo method and 5 iterations were performed. Markov Chain Monte Carlo refers to a collection of methods for simulating random draws from nonstandard distributions.

Data are presented as the mean ± standard deviation for continuous variables, proportions as nominal variable, and median (interquartile range [IQR]) for ordinal variables. We performed the Student *t* test to assess the difference between the 2 groups for parametric variables and Mann–Whitney *U* test for nonparametric variables. Chi-square test was performed to compare differences between the 2 groups for ordinal and nominal variables. Multiple logistic regression was performed to test the independent association of bicycle helmets with the dependent variables. Each dependent variable was treated as a binary outcome. All logistic regression models were adjusted for confounders that have previously shown to affect outcomes. These covariates were age, sex, race, insurance status, hypotension ($SBP < 90$), GCS, and ISS. For data analysis, we used statistical package for social sciences software (SPSS, V20.0; IBM, Inc., Armonk, NY). A P value less than .05 was considered statistically significant.

Results

A total of 6,267 patients were included with a mean age of 34.1 ± 20.6 years, 80.4% ($n = 5{,}040$) were male, and median ISS was 10 [5 to 17]. Overall, 52.4% ($n = 3{,}284$) of the population sustained a severe TBI and mortality rate was 2.8% ($n = 176$).

Table 1 represents the comparison of demographics and the injury severity between the helmeted and nonhelmeted groups. Patients in the helmeted group had significantly