



Outcomes in pediatric patients with recreational vehicle related forceful head impact



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ABSTRACT

Purpose: To compare outcomes in pediatric patients suffering forceful head impact during recreational vehicle use to patients with forceful head impact from other mechanisms.

Methods: Retrospective cohort study of all patients 3–18 years old who suffered forceful head impact (any traumatic mechanism strong enough to result in a face or skull fracture) in our institutional trauma registry between January 2011 and September 2013.

Results: Out of 252 events involving forceful head impact, 64 events were a result of riding a recreational vehicle. Although there is no difference in rates of temporal bone fractures, recreational vehicle accidents have higher rates of otic capsule violation (21% vs. 5%) and higher rates of hearing loss (30% vs 16%) compared to patients with forceful head impact from other mechanisms. All incidents of otic capsule violation and sensorineural hearing loss in recreational vehicle accidents were associated with a temporal bone fracture.

Conclusion: Despite the increasing use of head protective gear while operating a recreational motor vehicle there is still heightened risk for temporal bone fractures and subsequent hearing loss. The comparative associations in this study suggest that helmets used with recreational vehicles do not protect the temporal bone thus leaving vital structures within the otic capsule at risk for damage and long term consequences. When treating these patients Otolaryngologists should be aware of the elevated risk of otic capsule violation and late hearing loss with temporal bone fractures.

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1. Introduction

Childhood head injuries account for more than 600,000 emergency department (ED) visits per year and presumably a larger number of visits and calls to primary care providers [1]. Of these 600,000 visits majority are from childhood falls, however, approximately 40% of these cases will be due to recreational vehicle use [1,2]. Recreation vehicles include all-terrain vehicles (ATV), bicycles, and motorcycles. Although the majority of pediatric patients admitted to the hospital for head trauma are minor injuries, a select few will suffer from serious injuries with long term healthcare risks. This challenges physicians to make an

appropriate treatment plan directed at symptoms that may arise immediately or sometime in the future. The resulting symptoms of head trauma seem to vary by method of injury and thus are categorized and compared in this study.

Recreational vehicle use is immensely popular regardless of recent safety concerns posted by the media, medical field and private safety organizations. In the last 30 years the number of bicycle, motorcycle, and ATV sales increased dramatically due to their availability and reasonable cost. Unfortunately, government regulation and safety awareness fell many steps behind causing a dramatic increase in morbidity and mortality [3]. Although helmet use is encouraged during these types of activities, safety neglect is an increasing trend and the number of hospital admissions due to recreational vehicle accidents is increasing [4]. Many studies show that the severity of head injury is dependent on the use or non-use of a helmet, however, this study suggests that those who choose to wear helmets may actually be at similar risks for traumatic head injury. Current safety helmets fail to protect the skull against high

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accelerated head motions and lateral head impacts [5]. These flaws continue to keep the head at risk in high speed collisions and also leave the temporal bone vulnerable to injury.

It is often misconceived by the public that non-recreational vehicle head injuries (falls, car accidents, abuse, etc) are more clinically severe than head injuries due to recreational vehicles. This is a common misconception due to the spontaneity of non-recreational vehicle injury and the impossibility of continuous head protection throughout the day [5]. The purpose of this study is to compare outcomes in pediatric patients suffering forceful head impact during recreational vehicle use to patients with forceful head impact from other mechanisms.

2. Materials and methods

This study was performed at Nationwide Children's Hospital, a 420-bed free-standing tertiary care pediatric academic medical center in Columbus, Ohio operating as a referral base for central, northwest, and southeast Ohio. This study was approved by the Institutional Review Board at Nationwide Children's Hospital. We performed an electronic search of the institutional trauma registry for trauma events involving patients ≥ 3 years old and < 18 years old incurring forceful head impact who presented to our institution either as a transfer from other institutions or through our emergency department (ED) between June 2012 and September 2013. Forceful head impact was defined as any traumatic mechanism strong enough to result in a face or skull fracture. Data from each patient's chart were abstracted for patient age, gender, race, height, weight, facial and skull fractures, violation of the otic capsule defined as fracture involving the cochlea, semicircular canals, or vestibule, loss of consciousness, conductive and sensorineural hearing loss, facial nerve injury, intracranial hemorrhage, cerebrospinal fluid leakage, length of stay, admission to an intensive care unit, and death. Based on narrative descriptions of the event in the chart, patients were separated into two groups: those incurring injuries during recreational vehicle use and those incurring injuries from other mechanisms. Recreational vehicles included any wheeled vehicle for which helmet use is recommended; examples included all-terrain vehicles (ATVs), bicycles, and motorbikes. The patient involved in the trauma had to be riding the vehicle in order for it to be included in the recreational vehicle use group. Examples of other mechanisms included other forms of recreation such as skiing or football; automobile collisions; and falls from standing height.

Events that were and were not incurred during recreational vehicle use were compared based on demographics, initial clinical evaluation, diagnostic findings, and outcomes. Categorical variables were evaluated using chi-square and Fisher's Exact tests where appropriate, while continuous variables were evaluated using Wilcoxon rank-sum tests. All analyses were performed using SAS 9.3 (Carey, NC) and $P < 0.05$ was considered statistically significant.

3. Results

Out of 252 events that met study inclusion criteria, 64 events involved a child riding a recreational vehicle. Of the 79 temporal bone fractures identified, 10 patients were injured on all-terrain vehicles (ATV), 4 patients on golf carts, and 10 patients were injured riding a bicycle. Table 1 compares demographics and presenting factors between the two groups. Recreational vehicle riders were more likely to self-identify as white race, but otherwise did not differ from non-recreational vehicle riders. All patients had CT imaging (Table 2), and although there were also no differences in fracture patterns noted on imaging, recreational vehicle riders were more likely to have violation of the otic capsule.

Table 3 presents outcomes between the two groups. Recreational vehicle riders were more likely to present with late hearing loss. Table 4 presents outcomes specific to those patients who presented with a facial or a temporal bone fracture. Among patients with temporal bone fractures, recreational vehicle riders were more likely to have violation of the otic capsule or sensorineural hearing loss. All instances of violation of the otic capsule were associated with a temporal bone fracture and all instances of sensorineural hearing loss in recreational vehicle riders were associated with a temporal bone fracture.

4. Discussion

Despite no difference in rates of temporal bone fracture, recreational vehicle riders had higher rates of otic capsule violation and higher rates of sensorineural hearing loss. Furthermore, all incidents of otic capsule violation and sensorineural hearing loss in sport rider patients were associated with a temporal bone fracture. In fact, current literature suggests classifying temporal bone fractures as either otic capsule sparing or otic capsule violating as an indicator of clinical severity [6]. Using this newer classification

Table 1
Comparative demographics of patients.

Characteristic	Riding a recreational vehicle N = 64	Not on a recreational vehicle N = 188	Total N = 252	P-value
Age [median (IQR)]	12 (9–14)	11 (7–15)	11 (7–15)	0.3642
Race				
Black	3 (5)	36 (19)	39 (15)	0.0048
White	59 (92)	134 (71)	193 (77)	
Other	2 (3)	14 (7)	16 (6)	
Unknown	0 (0)	4 (2)	4 (2)	
Male gender	46 (72)	123 (65)	169 (67)	0.2135
Overweight*	20 (32)	51 (28)	71 (29)	0.3183
Obese**	11 (18)	27 (15)	38 (16)	0.3656
Loss of consciousness (NR: 31)	29 (53)	70 (42)	99 (45)	0.1135
ATLS trauma activation level				
Level 1	13 (20)	40 (21)	53 (21)	0.1374
Level 2	35 (55)	78 (41)	113 (45)	
Not activated as a level trauma	16 (25)	70 (37)	86 (34)	

Reported as number (%) except where indicated. IQR: Interquartile range.

* Defined as body mass index (BMI) at or above 85th percentile for age and gender.

** Defined as body mass index (BMI) at or above 95th percentile for age and gender.

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