

Injury Biomechanics Research - An Essential Analysis of Magnitude of Head Trauma and Impact of Patient Safety Factors in Road Traffic Accidents Involving Two Wheeler Riders

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ABSTRACT

This study aimed to predict injury patterns associated with different types of road traffic accidents involving two-wheeler riders, identify patient safety factors contributing to these injuries, and develop an injury analysis model. A total of 90 patients were divided into two groups: those involved in accidents with low motor vehicles and those with heavy motor vehicles. The study found that 95.6% of patients improved, with the majority managed conservatively, and lateral collisions were the most common type of impact (63.6%). Patients involved in lateral collisions had a higher incidence of severe injuries such as subdural hematoma (SDH), subarachnoid hemorrhage (SAH), diffuse axonal injury (DAI), and pneumocephalus compared to head-on and rear-end collisions. These findings suggest the need for improved patient safety measures, particularly for lateral collisions, to reduce injury severity and improve outcomes.

Keywords: Road Traffic Accidents (RTA), Two-wheeler Riders, Patient Safety Factors, Injury Patterns, Trauma Outcome, Injury Severity, Injury Analysis Model

INTRODUCTION

Road traffic accidents (RTA) remain a pressing global health issue, with the World Health Organization (WHO) predicting that by 2020, traffic fatalities would be the sixth leading cause of death worldwide and the second most common cause of disability in developing countries^{1,2}. Developing nations, particularly India, bear a disproportionate burden, with over 85% of global road traffic injuries occurring in these regions.³ The rapid increase in motor vehicles, especially two-wheelers,

contributes significantly to this problem, with two-wheelers accounting for more than 75% of registered vehicles in India.^{4,5} Young adults under 45 years are particularly at risk, with data showing that two-wheeler riders are 25 times more likely to suffer fatal head and neck injuries compared to occupants of four-wheelers.^{6,7} Although helmets have proven effective in reducing head injuries, compliance remains low, especially in low- and middle-income countries.^{8,9} Despite various road safety initiatives, including the United Nations'

Global Road Safety Week and the Brasilia Declaration, which aimed to halve RTA deaths and injuries by 2020,11, developing nations continue to see an increase in road traffic injuries and fatalities. This study focuses on analyzing head trauma mechanisms in two-wheeler RTAs, predicting injury patterns based on collision types, and assessing the impact of patient safety factors to guide improved injury prevention, management, and treatment protocols.12,13

MATERIALS & METHODS

Source of Data: The study was conducted prospectively in patients presenting with HEAD TRAUMA following accidents involving two wheeler riders to the Emergency Department at Vydehi Institute of Medical Sciences And Research Centre, Bangalore from September 2019 to January 2021.

Methods of collection of data

Study design: Prospective Cohort Study

Duration of study: 16 months

Sample size: 90

Inclusion criteria:

- Age-18-60
- Patients presenting to the ER with head injury resulting from any trauma such involving two wheelers such as: Two

wheeler with light vehicles and two wheeler with heavy vehicles

- Both male and female
- Patient giving will full written consent

Exclusion criteria:

- Age 60 age group
- Patients who sustained head injuries due to other mechanisms of road traffic accidents not involving two wheelers
- Patients brought dead to the hospital
- Patients who do not give will full consent

STATISTICAL ANALYSIS

The Statistical software SPSS 19.0 was used for the analysis of the data and Microsoft word and Excel have been used to generate graphs, tables etc. Descriptive and Inferential statistical analysis has been carried out in the present study. Results on continuous measurements are presented on Mean \pm SD and results on categorical measurements are presented in Number and Percentage.

Significance is assessed at 5 % level of significance. The chi-square test was used to check the association between the categorical variables. ANOVA was used to compare means of different variables across the groups. Cramer's V was used to determine the effect size. Statistic used for calculation of effect size-Cramers V.

Effect size (ES)	Interpretation
ES \leq 0.2	The result is weak. Although the result is statistically significant, the fields are only weakly associated.
0.2 < ES \leq 0.6	The result is moderate. The fields are moderately associated.
ES > 0.6	The result is strong. The fields are strongly associated.

Table 1: Stastical Interpretation

RESULTS

The study analyzed 90 patients involved in road traffic accidents (RTAs) while riding two-wheelers, with a focus on the biomechanical aspects of head trauma and the impact of patient safety factors. The key findings are summarized below:

Gender Distribution: Among 90 patients, 84 (93.3%) were male, and 6 (6.7%) were female. (Table 2)

Mechanism of Injury vs Glasgow Coma Scale (GCS): Patients in head-on and rear-end collisions had a mean GCS of 13.3, while lateral collisions had a significantly

lower mean GCS of 9.4 (p=0.0001). (Table 3)

Safety Factors:

Helmet Use: 44.4% of patients involved in head-on and rear-end collisions wore helmets, compared to 11.2% in lateral collisions (p=0.001). (Table 4)

Alcohol Consumption: Alcohol was involved in 44.4% of lateral collisions, with lower percentages for head-on (33.3%) and rear-end collisions (22.2%). (Table 5)

Injury Types:

Scalp Laceration: More common in lateral collisions (45.2%) compared to head-on (26.2%) and rear-end collisions (28.6%).

Contusion: Lateral collisions had the highest incidence (63.6%) (p=0.0001).

Extra Dural Hemorrhage (EDH): 84.6% of EDH cases were from lateral collisions (p=0.0001).

Sub Dural Hemorrhage (SDH): Lateral collisions also had the highest SDH incidence (68.4%) (p=0.0001)

Diffuse Axonal Injury (DAI): 81.8% of DAI cases were from lateral collisions (p=0.001).

Management and Outcome:

Management: 62.2% received conservative treatment, 35.6% underwent surgery, and 2.2% received supportive care.

Outcome: 95.6% of patients improved, while 4.4% died.

GENDER DISTRIBUTION

Table 2

Gender	N	%
Male	84	93.3
Female	6	6.7
Total	90	100

MECHANISM OF INJURY VS GCS

Table 3

Mechanism	N	MEAN	SD	STD.ERROR	F	p
HEAD ON COLLISION	32	13.2500	1.66559	.29444	26.7	0.0001*
LATERAL COLLISION	30	9.4000	3.06931	.56038		
REAR END COLLISION	28	13.3214	2.21198	.41802		

MECHANISM OF INJURY VS PATIENT SAFETY FACTOR HELMET

Table 4

Mechanism	Helmet				Chi sq	Effect size	p
	Yes		No				
	N	%	N	%			
HEAD ON COLLISION	16	44.4	16	28.6	13.6	0.38	0.001*
LATERAL COLLISION	4	11.2	26	48.1			
REAR END COLLISION	16	44.4	12	22.2			

MECHANISM OF INJURY VS PATIENT SAFETY FACTOR ALCOHOL

Table 5

Mechanism	Alcohol				Chi Sq	Effect size	p
	Yes		No				
	N	%	N	%			
HEAD ON COLLISION	9	33.3	23	36.5	2.4	0.1	0.2
LATERAL COLLISION	12	44.4	18	28.6			
REAR END COLLISION	6	22.2	22	34.9			

DISTRIBUTION OF STUDY PARTICIPANTS MANAGEMENT

Table 6

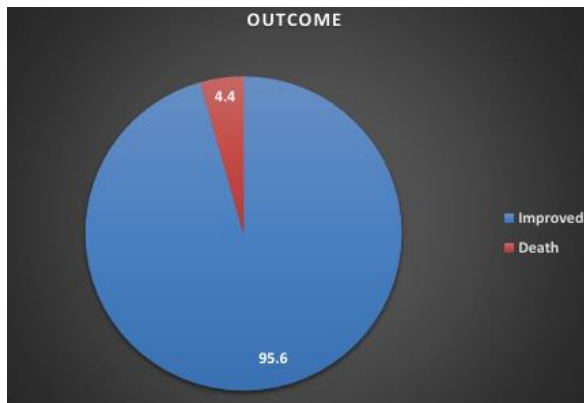
Management	N	%
Conservative	56	62.2
Supportive	2	2.2
Surgical	32	35.6
Total	90	100.0

OUTCOME

Table 7

Outcome	N	%
Improved	86	95.6
Death	4	4.4
Total	90	100.0

Figure 1



DISCUSSION

Trauma presents significant challenges for both surgeons and patients due to its unpredictable nature and the severity of complications that can arise. Early intervention, including primary care focused on maintaining airway, breathing, and circulation (ABC), plays a crucial role in patient prognosis. Despite the availability of safety gear like helmets, shoes, and jackets, their regular use remains limited, particularly among motorcycle riders, who are highly prone to injuries. Motorcycles are associated with a disproportionately high rate of road traffic accidents (RTAs), often resulting in severe outcomes, including death. The incidence of it being the most common reason can also be attributed to the fact that it is also the most commonly used mode of transport especially in a country like INDIA which is still a developing country.⁵ An incident on the motorcycle would mean trauma, be it high or low speed with the amount of trauma being directly proportional to the speed of the impact. In our study we have tried to analyze the impact of such motorcycle crash with the physics involved and the type of management required for a better approach in treating such patients during emergencies. In our study we found that the majority of the injured individuals were males in comparison to females which were about 93.3% in comparison to the 6.7% of females who were injured in road traffic accidents. This can be attributable to various aspects like males predominantly using motorcycles and their involvement in outside work over

the female gender. Also, males tend to travel at a higher average speed in comparison to females which would increase the risk of an accident exponentially. Menon et al in the year 2008 from his study showed that the male population was victims of Road traffic accidents, which were caused by non-compliance of traffic rules and regulations, including the possession of fake driving licenses.¹⁴

We also found that individuals who had a head on collision showed a higher GCS Score in comparison to the individuals who suffered a lateral or rear end collision. The mean GCS Scores recorded for individuals with head on collision, lateral collision and rear end collision was 13.25, 9.4 and 13.32 respectively. We found a statistical significance on inter-group comparison of the patients. The Glasgow coma scale is a reflection of the severity index of the trauma suffered by the patient. Glasgow coma scale assessment evaluation helps us to understand that the level of trauma shows the maximum severity when the patient suffers from head on collision in comparison to the other types of collision. Following the rear end collision there are higher chances that the person may land on the front of the car that hit the vehicle or the person may also land up crashing into the front vehicle with it causing him to strike himself with the front vehicle. The head on collision sends the person in a front position wherein there are higher chances of trauma to the head and neck region as that portion may be the primary site of impact with the vehicle in the front. Our study showed that most of the patients suffered from rear on collision; however the parameters showed that most of them were observed when the patient had a lateral collision. All such parameters may indicate towards a more improbable hit position affecting the vital organs and being reflected by the parameters being positive. On assessment of patients wearing helmets who suffered injuries, we found that patients who had head on collision as well as rear end

collision were the major sufferers as both these groups had 16 individuals with trauma in comparison to a minimal of 4 individuals who suffered lateral collision. We found a statistically significance on inter-group comparison of the patients. 62 In case of a head on collision, there is a direct transfer of the forces in a direction similar to the direction of the travel as the impact brings the movement to a sudden halt and leads to transfer of the energy to the rider. This energy transfer is transmitted to the tissues of the body with an abrupt change in the inertia levels. The change in the kinetics of the body from the state of rest to these energy levels can lead to dislocation or distortion of the associated structures. A lot of evidence based data suggests that non usage of helmets increases the risk exponentially. Helmets lessen the hazard and incidence of mutually head injuries and death owing to motorcycle accidents and in turn lessen hospitalization and morbidity.¹⁵ In case of patients with scalp laceration, we found that about 45.2% individuals had lateral collision, followed by rear end collision and head on collision. We found a statistically significance on inter-group comparison of the patients. In case of patients with base of skull fracture, we found that about 44.7% individuals had lateral collision, followed by head on collision and rear end collision. Our results showed that on an average about 45% of the patients suffered skull fracture as well as scalp laceration indicating a high rate of injury to the head region which may indicate that these patients were not wearing helmet which reflects the level of negligence of the patient leading to the severity of the condition. Enforcement of the helmet rule is highly required for the safety of the individuals as only enforcement is the way to save lives and not just the mere availability of the helmets in the market. Latha ganti et al conducted an observational cohort study in the year 2013 about the impact of helmet use in traumatic brain injuries associated with recreational vehicles. The study was conducted on a

cohort of 478 patients and concluded that the lack of helmet use is significantly correlated with abnormal head CT scans, admission to the ICU and worse TBI severity.¹⁶ When the patients were assessed in the presence of risk factors like under the influence of alcohol, we found that patients who had lateral collision formed the 64 majority of about 44.4%, followed by head on collision was 33.3% and rear end collision was 22.2%. The ability of the patient to make a judgement while driving is severely impaired when the person consumes alcohol. Driving is a skill which requires accuracy as well as quick judgement to react spontaneously at the situation. A study done by Harry Hurt et al., 2011 testified that more than 50% of the fatal accidents were under the influence of alcohol.¹⁷ In case of patients with contusion, we found that about 63.6% individuals had lateral collision, followed by head on collision and rear end collision. We found a statistical significance on inter-group comparison of the patients. In case of patients with EDH, we found that about 84.6% individuals had lateral collision, followed by head on collision and rear end collision. We found a statistical significance on inter-group comparison of the patients. 65 Individuals who suffered lateral collision were seen to have higher levels of SDH, SAH, DAI & pneumocephalus involvement than rear end collision and head on collision. We found a statistical significance on inter-group comparison amongst the patients Astonishingly our parameters indicated that lateral type of collision patients were the most common patients who were affected. Even though lateral type of collision showed the second most higher levels of GCS levels in comparison to head on collision, still lateral type showed all the predominant levels for scalp laceration, contusion, EDH, SDH, SAH, pneumocephalus, base of skull fracture and DAI. Lateral impact throws the rider in a direction away from the side of collision. Most commonly compressive pelvic injuries, pulmonary contusion, intra-

abdominal solid organ injuries and diaphragmatic rupture have been reported in case of lateral type of collision. We were able to manage the majority of the patients by conservative approach (62.2%) in our study and others with surgical approach (35.6%) and a meagre 2.2% with supportive management. Conservative management delivered us with favorable treatment outcome over other treatment modalities which would also mean less complication over the surgical management of patients. Conservative management of patients has been highly recommended across all treatment modalities by physicians and surgeons universally. The management protocol being purely dependent on the patient trauma status and the action plan needed to stabilize the vitals. Our study showed better results as treatment outcome with over 95.6% 66 patients showing improvement over 4.4% patients who suffered death. With the accomplishment of such high recovery rates we were very much satisfied with the treatment protocol we followed but a recovery rate of 100% would have made our treatment protocol a better success. From our study we tried to have a better understanding of the type of impact, its effects, the organs affected, the immediate response and the treatment done. Even though we tried to understand the kinematics of the trauma process still it becomes an unaccomplished goal to understand the same as trauma is a complex process with many compounding factors added to it to arrive at a conclusion which may still be somewhat dilemmatic.

CONCLUSION

In our study males were the most common patients accounting for 93.3% male patients which can be attributable to various aspects like males predominantly using motorcycles at high speeds in an external work environment. About 95.6% patients showed improvement over 4.4% patients who suffered death with predominant management being the conservative approach (62.2%) followed by the surgical

approach (35.6%) and a meagre 2.2% with supportive management. Conservative management delivered us with favorable treatment outcome over other treatment modalities which would also mean less complication over the surgical management of patients. However, a recovery rate of 100% was our treatment goal which could not be accomplished. Our goal was to correlate the trauma suffered against the angle, side and speed and many factors, all of which helps determine and understand the kinematics of the trauma suffered during the accident. It also helps to initiate the treatment plan at the earliest to achieve the most favorable treatment outcome as well as the prognosis Conservative management of patients is highly advocated across all treatment modalities by physicians as well as surgeons with the primary goal being the stabilization of the vitals with the “ABC” approach being the primary.

Declaration by Authors

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