

January - June 2023

Volume 32

Issue 1

PRINT ISSN: 2277-1867

ONLINE ISSN: 2277-8853



JOURNAL OF FORENSIC MEDICINE SCIENCE AND LAW

Official Publication of Medicolegal Association of Maharashtra

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**MULTISPECIALITY, MULTIDISCIPLINARY, NATIONAL
PEER REVIEWED, OPEN ACCESS, MLAM (SOCIETY) JOURNAL
Indexed with Scopus (Elsevier) & Index Copernicus (Poland)**

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JOURNAL OF FORENSIC MEDICINE SCIENCE AND LAW

(Official Publication of Medicolegal Association of Maharashtra)

Email.id: mlameditor@gmail.com

PRINT ISSN:

2277-1867

ONLINE ISSN:

2277-8853

Original Research Article

Pattern of Fatal Injuries Sustained by Two-Wheeler Riders Due to Road Traffic Mishap in Agra Region

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Article Info

Received on: 08.11.2022

Accepted on: 19.03.2023

Key words

Road traffic,
Accident,
Two-wheeler accident,
Fatal head injuries.

Abstract

Introduction: Prospective autopsy-based study was conducted on two-wheeler riders who were victim of fatal road traffic accident (RTS), to find pattern of fatal injuries sustained by them & to know their relevant sociodemographic profile. **Material & methods:** 136 cases fulfilling the criteria are discussed in detail. **Results:** Majority of them (76.5%) were motorized two-wheeler riders. Male (91.2%) were more involved in fatal mishap. People between 21-30 years were most commonly effected (29.4%). Most victims receive multiple fatal injuries in various regions of body. Specially in head region (80.9%), followed by thorax region (28.7%). Head is most vulnerable region to receive fatal injuries and scalp laceration (66.9%) was commonest external injury on head. In thorax, rib fracture was commonest significant finding (27.2%), internally laceration of lung (18.4%) was commonest finding. In abdominal peritoneal hemorrhage was commonest sign (20.6%) and laceration of Liver was most common fatal injury (18.4%). **Conclusion:** Head is most vulnerable region to receive fatal injuries. Data can help to amend rules for safe commutation of two-wheeler riders and guide for swift management of injured.

1. Introduction

Accident is defined in dictionary as "An undesirable or unfortunate happening that occurs unintentionally and usually results in harm, injury,

damage, or loss; casualty; mishap."¹ Road traffic accident (RTA) constitute major portion of fatal accident.

How to cite this article: Gupta A, Singh G, Gupta P, Kumar A, Verma A. Pattern of Fatal Injuries Sustained by Two-Wheeler Riders Due to Road Traffic Mishap in Agra Region. J For Med Sci Law 2023;32(1):25-31.

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According to institute national de la statuesque "A traffic accident is defined as an accident involving at least one vehicle on a road open to public traffic in which at least one person is injured or killed."² Global Status Report on Road Safety 2018 by World Health Organization states "Road traffic accident (RTA) causes death of 1.35 million commuters annually. Road traffic injuries has become leading cause of death of people in age group of 5-29 years. It is the 8th leading cause of death for all age groups. This burden is disproportionately borne more by pedestrians, cyclists and motorcyclists, particularly on those who are living in developing countries. Road traffic crashes cost most countries 3% of their gross domestic product."^{3,4}

Report by Ministry of Road Transport & Highways, India, 2019 states "India ranks first in the number of road accident deaths across the 199 countries and accounts for almost 11% of the accident-related deaths in the World. It is nearly 20 times more than that reported in developed countries."^{4,5} National Crime Record Bureau of India recorded 3, 54,796 RTA in India in 2020 causing 1, 33,201 deaths. In Uttar Pradesh, 28,653 road accidents caused 19,037 deaths and injuries to 15,982 persons.⁶ Ministry of Road Transport & Highways, India, recorded 906 RTA in Agra region causing 514 deaths and injuring 633 people in 2020.⁷ Report by US Department of Transportation states "motorcyclists are about 29 times more likely than passenger vehicle occupants to die in a motor vehicle crash and were 4 times more likely to be injured".¹⁰ There is need to carry out studies which can highlight lacking areas which leads to fatal RTA, especially in case of two-wheeler, this can be achieved by correlating pattern of fatal injuries and socio-demographic profile of victim of fatal RTA.

2. Material & Methods

This prospective autopsy-based study was conducted in a tertiary level health care & medical education Institute in Agra region, between February 2012 to July 2013 after taking necessary permission. The aim of study was to know socio-demographic profile of victims of fatal RTA and to find out the pattern of fatal injuries inflicted on them by RTA. People who died due to road traffic mishap while commuting on two-wheeler and brought for postmortem examination at designated mortuary were included in the study. Cases with incomplete history, partially healed injuries or decomposed

bodies were excluded from the study. Data was collected as per the preformed format. Information about socio-demographic profile of victims and conditions prevailing during fatal accident were noted from police inquest report. Details about the fatal injuries were collected from post mortem examination records. Identity of case (victim of RTA has not been disclosed). Data was statically analyzed by SPSS software.

3. Results

During the study period, a total of 450 cases due to fatal road traffic mishap were examined during autopsy. Out of which 136 (30.2%) cases (two-wheeler riders who die due to RTA) are included in present study. More than 3/4th of victims (104, 76.4%) were motorized two-wheeler (like motorcycle, scooter, moped etc.) riders, while about 1/4th (32, 23.5%) were pedal cyclist, as shown in **Table 1**. Male (124, 91.2%) were found to be affected much more than female (12, 8.8%) in fatal RTA. Majority of victims belong to the age-group of 21-30 years (40, 29.4%).

Table 1: Distribution of cases according to type of road user, gender and age.

S. No.	Type of road user	Male		Female		Total	
		Cases	%	Cases	%	cases	%
1	Occupant of motorized two-wheeler (motorcycle, scooter etc.)	94	69.1	10	7.35	104	76.5
2	Pedal Cyclists	30	22.1	2	1.5	32	23.5
Total cases		124	91.2	12	8.8	136	100

Maximum number of fatal mishaps (25, 18.4%) occurred during the evening rush hours i.e., between 6:00 PM to 8:59 PM. Fatalities were found to occur more on highways (80, 58.6%), followed by village road (24, 17.6%) and city road (22, 16.2%), as shown in **Table 2**. The most common highway involved was National Highway (NH) 19, followed by NH 3, 39, 44 and Yamuna express way. Most of the mishap (61, 44.9%), occur due to indulgent with heavy motor vehicles (buses, trucks, tripper etc.) followed by involvement with light motor vehicle like cars, jeeps, etc. (61, 44.9%), as shown in **Table 2**. Many cases receive multiple fatal injuries on various regions of body. Out of 136 cases, majority got fatal injuries in the head region (110, 80.9%) followed by thorax (39, 28.7%) and abdomen region (31, 22.8%), as shown in **Table 3**. Many cases have multiple fatal

injuries in head region. Laceration on the scalp (n=91, 66.9%) was found as most common significant injury or sign of dreaded internal injury, cases with skull fracture (including fissure fractures) were 70 (51.5%). Within cranial cavity focal hematoma in meningeal space were found as commonest significant injuries (92, 67.4%), out of which subdural hematomas (SDH) was most common (65, 47.8%), as shown in **Table 4**. Gross lesion in Brain parenchyma i.e., laceration or blood-filled ventricle, Trans-tentorial Herniation brain and lesion in brainstem lesion were found in 45 cases (33.1%) as shown in **Table 4**.

Table 2: Distribution of cases according to time, place and indulging vehicle or condition

S. No.	Time of accident (24-hour format)	No. of cases	%
1	00:00-02:59	7	5.1
2	03:00-05:59	12	8.8
3	06:00-08:59	17	12.5
4	09:00-11:59	23	16.9
5	12:00-14:59	18	13.2
6	15:00-17:59	20	14.7
7	18:00-20:59	25	18.4
8	21:00-23:59	14	10.3
Total		136	100
Place of accident			
S. No.	Place of accident	No. of cases	%
1	Highway	80	58.8
2	Village roads	24	17.6
3	City roads	22	16.2
4	Other place (drain/ canal/ farm/ undefined etc.)	10	7.4
Total		136	100
Offending agent/ Vehicle			
S. No.	Offending agent/ Vehicle	No. of cases	%
1	Heavy vehicles (trucks, buses etc.)	61	44.9
2	Light motor vehicle (Two-wheeler, cars, jeeps, etc.)	48	35.3
3	Others – fall in drainage, sewage, collision with stationary object like tree, wall, rock etc.	18	13.2
4	Unknown	9	6.6
Total		136	100

Table 3: Body region with sustained fatal injuries.

Body region	Cases	% Prevalence
Head (including face & neck)	110	80.9
Thorax	39	28.7
Abdomen (including pelvis)	31	22.8
Limb - crush or amputation	11	8.1

Table 4: Distribution of injuries in head (N=110)

Head region	Cases	% Prevalence out of 110 head injury cases	% Prevalence out of total 136 cases
Scalp laceration	91	82.7	66.9
Fracture of skull, face	70	63.6	51.5
Focal hematoma- EDH SDH SAH	92	83.6	67.4
	54	49.1	39.7
	65	59.1	47.8
	53	48.2	38.9
Gross lesion in Brain and brain stem	45	40.9	33.1

Table 5: Distribution of injuries in thorax region.

Thorax region	Cases	% Prevalence out of 39 thorax injury cases.	% Prevalence out of total 136 cases.
Fracture of ribs, sternum	37	94.9	27.2
Laceration of lung/ Hemothorax	25	64.1	18.4
Laceration/ contusion of Myocardium/ pericardial fluid	5	12.8	3.7

Table 6: Distribution of injuries in abdomen region.

Abdominal injuries	Cases	% Prevalence out of 31 thorax injury cases	% Prevalence out of total 136 cases.
Peritoneal hemorrhage	28	90.3	20.6
Laceration of Liver	25	80.6	18.4
Laceration of spleen	11	35.5	8.1
Laceration of kidney	7	22.6	5.1

Fatal injuries in thorax region were found in 39 (28.7%) victims. Rib fracture (37, 27.2%) was most common significant sign of fatal injuries in thorax, laceration of lung (25, 64.1%) was commonest fatal intrathoracic injury and hemothorax has been found almost common sign, as shown in **Table 5**. Fatal injuries in abdomen & pelvis region were noted in 31 (22.8%) cases. Peritoneal hemorrhage (28, 20.6%) was found to be as most common sign of significant injury. Laceration of liver (25, 80.6%) was most common intraabdominal fatal injury, as shown in **Table 6**.

4. Discussion

In million years of human history, first fatal road traffic accident occurs in 1869⁸ and within 150 years it become 8th most common cause of death.³ Human have created one of largest pandemic for themselves. Exponential growth of population, rapid motorization, deficiency of road infrastructure, lacking proper driving skill and above all ignoring traffic law, leads to ever increasing road traffic mishap.^{3, 9} During two-wheeler riding, minor disturbance, such as abrupt reduction of speed, damaged road, bump, pot hole, bad weather etc. can easily lead to disbalance & fall. On top of that two-wheeler lacks external structure, so riders are fully exposed and are more prone to get direct impact injuries from fall on road or other object (for e.g., heavier vehicles) which are at much different momentum, this cause severe injuries to two-wheeler rider at multiple anatomical sites.^{4,11}

Out of total 450 victims of fatal road traffic mishap, 136(30.2%) were two-wheeler riders. Similar observations were noted in various studies.^{12,13} Report by Ministry of Road Transport and Highways states that prevalence of two-wheeler in fatal total road traffic accidents varies between 10 to 30%.¹² Study by Sahu G, Choudhury JC, Mallick DK claimed that 24.6% victim of fatal RTA were two wheelers' riders.¹³ Socio-demographic and injury profile of these 136 are discussed here. Out of 136 cases, majority (76.5%) were commuting on motorized two-wheeler and 23.5% were riding on pedal cyclist while they meet fate. This may due to the fact that motor cycle gains speed more rapidly and are much heavier than cycle, so many times they are difficult to balance/ control, especially when there is need of sudden decrease in speed. While pedal cycle remains at lower speed, so its rider has lesser chances to get severe injuries.

Majority of the cases belong to age group of 21-30 years (29.4%). Similar observations were noted in many other studies.^{3,14-20} WHO'S Global Status Report on Road Safety 2018 states also states that Road traffic injuries are now the leading killer of people aged 5-29 years.³ Study by Slater S, Subramaniyam S, Chandran R shows that majority (72, 30.9%) of victims belongs to group of 20 to 29 years of age.¹⁴ This may be due to fact that, in this age group people are generally more active and indulged in career building & risk involving activities, which often induces for ruthless driving, also lack of

financial buildup compels them to commute by low-cost vehicle like two-wheeler.

Majority of cases were male (91.2%) while only 8.8% female. Similar observation are mentioned in many other studies.^{14,15, 21-23} Study by Slater S, Subramaniyam S, Chandran R, mentioned more that 93.1% victim of fatal two-wheeler RTA are male.¹⁴ Study by K.Prasannan, P.A. Sheeju , mentioned majority (94.1%) were male.¹⁵ Male have always been more exposed to RTA, as traditionally they have responsibilities of bread winning activities and have to perform more outdoor chores than female, often these activities, demand timely completion, stress, rash driving and thus increases chances of accident.²⁰⁻²⁴ This ratio is even more disproportionate in case of two-wheeler, as in Indian females traditionally avoids / or have been denied to use two-wheeler.

In the present study, maximum number of accidents (18.42 %) were found to occur between 6 pm to 9 pm. Similar findings were also noted in many other studies.^{14,19} Study by Slater S, Subramaniyam S, Chandran R stated that maximum number of accidents (39.2%) occurred between 6 pm to 12 am.¹⁴ Study by Seethalakshmi M, Sudalaimuthu R, Mahendran J, Nagendrakumar observed that majority of accidents (39.5%) took place between 6 pm to 12 am.¹⁹ This may be because it is one of peak traffic density time, people want to rush home after office in this time period. In the present study, majority of fatal accidents were found to occur on highway (58.8%). Study by Shruthi P, Varsha S observed found that majority (68%) of fatal two-wheeler accidents occur on National highways.²⁰ This may be due to fact that on highway provides opportunities of faster commutation, common city dwellers are not acclimatized to high-speed commutation and thus meets mishap.

In the present study, majority (44.9%) of mishap occur due to involvement of two wheeler with heavy vehicles (trucks, buses) either head-on collision, sideways or over run, this finding is in accordance with many other studies.^{14,15} Study by Slater S, Subramaniyam S, Chandran R mention that majority(56.7%) of fatal accidents of two wheeler occur due to collisions with 4 wheeler.¹⁴ Similarly Study by K.Prasannan, P.A. Sheeju found that majority of fatal two wheeler mishaps were caused due to involvement with Bus (21.5%), followed by Lorry (17%) and Tipper(11.1%). Combinedly heavy vehicles were involved in 49.6% of fatal two-wheeler

RTA.¹⁵ In the present study, 80.8% of cases were found to have fatal injuries in their head & neck region. Blunt force injury in head region have been common cause of death in RTA. Similar pattern is found in many other studies too.^{14, 15} Study by Slater S, Subramaniyam S, Chandran R state that 94.6% cases significant injuries in head region.¹⁴ Study by K.Prasannan, P.A. Sheeju found that 70.23% drivers and 66.66% pillion riders of fatal two-wheeler mishap got fatal injuries in head region.¹⁵

Study by Piantini et al. found that majority of cases (55%) got significant injuries in head region. scalp contusions were found as most common external injury.¹⁷ This may be due to fact that in case of two-wheeler ride, any disturbance in ride may lead to disbalance and fall of rider. Head is highest region of body, so on falling down it will strike ground/object with higher momentum than other body part, also two-wheeler lacks external structure. Along with that, skull is non elastic structure so any external impact force will be transmitted intracranially with least dampening, thus cause greater damage. Any intracranial hemorrhage will lead to increase in intracranial pressure which will hamper blood flow causing further increase injury, oedema, ICT and vicious cycle of damage.²⁵ In the present study, laceration on scalp was found in 66.9%. It is one of the most common significant external injuries on head region (apart from other simple injuries like abrasion, contusion). Other researchers also noted similar finding.^{14,15} Study by Slater S, Subramaniyam S, Chandran R shows that 75.1% cases got scalp laceration.¹⁴ Study by K. Prasannan, P.A. Sheeju observed that laceration in head region were present in 29% driver & 23.5% pillion rider victim of RTA.¹⁵

In the present study, skull fractures fracture was found in 51.9 % cases. Similar observations were found other studies too.^{14, 15} Study by Slater S shows that 63.5% cases got fracture in skull, out of which majority were fissure fracture of calvaria.¹⁴ Study by K. Prasannan, P.A. Sheeju found fissure fracture in 32.59% of cases.¹⁵ In the present study, focal hematoma around meningeal layer were found to be the most common significant of intracranial injury. Subdural hematoma (SDH) was found as most common type of focal hematoma- found in 47% cases, followed by Epidural hematoma (EDH) (39.7% cases) & Subarachnoid hematoma (SAH) (38.9%), Intra parenchymal hemorrhage were least common hemorrhage. Similar observations are mentioned in

other studies too.^{15, 26, 27} Study by K.Prasannan, P.A. Sheeju found that focal brain injury were in 78.51% cases, SAH in 65 -67.87% of cases.¹⁵ Study by Sagar SMK states that combination of SDH and SAH accounted for 40% of cases.²⁶ Study by Amir A, Hoda MF, Khalil S, Kirmani S found intra cranial haemorrhage in 85.9% of cases, out of which SAH accounted for 55.8%.²⁷

Many cases have multiple intracranial hematomata in different layers of meninges, sometimes laceration /tearing of meningeal lead to difficulty in differentiating/ isolating them. Meningeal hematoma (mostly SDH) occurs due to tearing of bridging veins by external blunt force injury. Superficial (Meningeal) hematoma can be readily managed with early diagnosis and its drainage with burr hole.²⁸ In the present study, 39 (28.7%) cases were found to have fatal injuries in thorax region, it is second most common inflicted region of body. Out of them, 27.2% got rib fracture, while 18.4% have laceration of lung with haemothorax. Similar findings were mentioned in other researches too.^{11,15} Study by Sharma BR, Gupta N, Sharma AK, Sharma S found that with in thorax, rib fracture was present in 40.3% cases, sternum fracture in 3.73% cases, Haemothorax in 12.69% cases, Lung contusion/laceration in 9.7% cases Myocardial contusion/tear in 6.72% cases.¹¹ Study by K. Prasannan, P.A. Sheeju. found that among fatalities in two-wheeler occupants 51.19% driver and 43.13% rider of two-wheeler got fatal injuries in thorax, it is second most common region to receive fatal injuries.¹⁵ The lungs occupy most of the thorax and thus more vulnerable to injury than heart. In present study 22.8% cases have fatal injuries in abdomen & pelvis region. Peritoneal hemorrhage 20.6% was most common sign of significant intraabdominal injury. Laceration of liver (18.4% cases) was found as most common fatal intra-abdominal injury, followed by lacerated spleen (8.1%) & kidney. Similar finding was stated by other authors also.^{4,11}

Study by Gupta V et al found that abdominal injury was cause of death in 15.7% cases. They found that out of all abdominal injuries 27.8% got fatal injuries in Liver, 19.2% got fatal injuries in Spleen, 13.6% got fatal injuries in Kidney.⁴ Study by Sharma BR, Gupta N, Sharma AK, Sharma S found that Liver laceration was present in 27.6% cases, spleen rupture 20.2 % cases, kidney rupture in 10.5% cases, Intestinal perforation in 4.5% cases Myocardial contusion/tear

in 6.72% cases.¹¹ Liver being the largest internal organ, lying anteriorly often receives blunt force trauma, along with it organs lack elastic tissue which can control bleeding. The WHO mentions following new risk factors for vulnerability in road traffic accidents in 2021- socio economic status of countries, age, speeding with and without alcohol consumption, correct helmet use, distracted driving by mobile and hands-free usage, inadequate post-crash care, and inadequate traffic laws.³

5. Conclusion

Integrated efforts should be initiated from governmental, non-governmental organizations and society to check RTA. Data obtained can highlight loopholes in road safety. Often fatal deep intracranial focal hematoma presents with minor external head injuries like abrasion or contusion, leading to its omission. Prompt action should be taken by competent at local authority level bypassing long waiting.

6. Recommendations

- There should be more stringent rules & their implementation to ensure use of helmet by drivers and pillion riders.
- Government should restrict number of vehicles on road, by allowing only one four-wheeler per family especially in metro cities.
- Continuous monitoring with AI enabled surveillance camera, which can identify defaulter & automatic send notification or challan
- Teaching of road traffic law and rule in school, driving subject should be included in school level with temporary driving licensing facility (may be for without gear two-wheeler)
- Initial training via online/ virtual training modules.
- There should be compulsory special training for drivers of heavy & public transport vehicle (Truck, bus etc.) before allowing them on highway.
- Private and government institute should restrict entry/ exit of two-wheeler riders in their premises, who are riding without helmet.
- Separate path for two-wheeler or slow vehicles along highways.
- Establishing basic level health facility along road along with specialized ambulance equipped with critical care equipment.
- Basic level health care provider should be trained to identify obscured injuries/ head injuries in RTA, so that treatment can be started promptly in specialized ambulance and secondary hospital.

Ethical Clearance: IEC approval is taken from the Institutional Ethical committee.

Contributor ship of Author: All authors equally contributed.

Conflict of interest: None to declare.

Source of funding: None to declare.

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