Original Article

Evaluation of the effectiveness of road safety measures and their impact on the pattern and distribution of extracranial and intracranial hemorrhages in fatal head injury cases in Uttar Pradesh, India

ABSTRACT

Introduction: In Uttar Pradesh, India, there are many fatal head injuries as a result of road traffic accidents (RTAs). Studying the pattern and distribution of intracranial hemorrhages, a frequent complication of severe head trauma might provide vital information on the efficacy of traffic safety regulations. To improve road safety tactics and lower fatal head injuries in Uttar Pradesh, this study intends to assess the effect of road safety measures on the frequency and distribution of intracranial hemorrhages in fatal head injury patients.

Aim: This study's objective is to assess the influence of current road safety initiatives on intracranial bleeding distribution and patterns in fatal head injury cases in Uttar Pradesh.

Methodology: The 604 RTA cases with head injuries that were brought to the mortuary of the S.R.N. Hospital in Prayagraj for a medical-legal postmortem assessment over the course of a year, from April 2021 to March 2022, make up the entirety of this prospective study. Following receiving institutional ethical approval and informed consent, structured interviews with attendees utilizing a questionnaire were done to gather the data.

Result: The results show that certain traffic safety measures have reduced the frequency of fatal head injuries in RTAs. A decreased incidence of intracranial hemorrhages was linked to improved traffic infrastructure, including well-planned junctions, pedestrian crossings, and distinct bicycle lanes. Similar results were shown in serious head injuries when traffic restrictions including speed limits, seat belt use, and helmet legislation were strictly enforced.

Conclusion: There are still issues with fatal brain injuries from car accidents, despite some encouraging results. Safety legislation violations, a lack of public knowledge, and inadequate enforcement all contribute to the issue. Disadvantaged groups like walkers and users on two-wheelers continue to be especially susceptible. The results of this investigation offer important new understandings of the efficiency of traffic safety measures and their influence on the distribution and pattern of cerebral hemorrhages in Uttar Pradesh, India. The results point to the necessity of improved public education efforts and traffic safety laws. More research and focused interventions are required to address specific risk factors among various road user groups. This will result in a safer driving environment and a decline in catastrophic brain injuries.

Keywords: Distribution, effectiveness, fatal head injury cases, intracranial hemorrhages, road safety measures, road traffic accidents

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INTRODUCTION

Road traffic accidents (RTAs), which cause millions of lives and injuries each year, are a serious global public health problem.[1] A significant amount of the mortality load among the numerous injuries brought on by RTAs is caused by fatal head injuries.[2] A typical result of severe head trauma is intracranial hemorrhages, which are defined by bleeding inside the skull and are frequently linked to a bad prognosis.[3] Understanding the location and pattern of these intracranial hemorrhages in fatal head injury cases might help advise tactics to lessen the frequency and severity of such accidents and useful insights into the efficacy of traffic safety measures.[4] One of the biggest states in India, Uttar Pradesh, has a significant number of RTAs each year, leading to several fatalities and injuries.[5] Significant worries about road safety are raised by the state's quickly expanding population, rising motorization, and infrastructural issues.[6] The government and many stakeholders have made an effort to increase road safety measures and lessen the effects of RTAs. Among these actions are public awareness campaigns, infrastructural upgrades, and the enforcement of traffic laws.[7] But it is critical to assess how well these therapies work, particularly in connection to catastrophic head injuries and intracranial hemorrhages.[8] In Uttar Pradesh, India, research is being done to assess the efficiency of traffic safety measures and their influence on the distribution and pattern of intracranial hemorrhages in fatal head injury patients.[9] A thorough knowledge of the relationship between road safety measures and the pattern of injury may be gained by studying the data linked to fatal head injuries arising from RTAs, including the exact locations and types of intracranial hemorrhages. The World Health Organization (WHO) has identified several key risk factors for road injuries, including speed, alcohol, seat belts, helmets, child restraint seats, and visibility. Speeding plays a critical role in the occurrence of fatal accidents.[10] The higher the speed of a vehicle, the greater the impact, leading to more severe and potentially fatal consequences. In fact, up to one-third of RTAs can be attributed to excessive speed. Recognizing this, researchers have proposed stricter alcohol limits for young or inexperienced drivers to reduce the occurrence of RTAs.[11] To address the significant role of alcohol in road accidents, India has implemented measures such as random breath testing at police checkpoints and breath and blood testing of drivers involved in accidents.[12] Seat belts are essential safety measures that offer substantial protection against serious injuries or fatalities.[12] Proper usage of seat belts can significantly reduce the risk of being ejected from a vehicle, colliding with the windshield, or sustaining injuries even when these may not be the primary cause of the accident.[13] They provide a 40% to 65% safeguard against severe mortality or injury.[14] Motorcycle riders face an alarmingly higher risk of death in traffic accidents compared to those in four-wheelers. The United Nations Motorcycle Helmet Study highlights that motorized two-wheeler motorcyclists have a 26 times greater risk of dying in a traffic accident. However, wearing high-quality helmets correctly can increase survival rates by 42% and reduce injuries by 69%. Driver behavior also plays a significant role in road safety.[15,16] Many participants admitted to engaging in avoidable risky behaviors while driving, such as using speaker phones, making calls, and listening to music.[17] A smaller percentage acknowledged watching videos and using Bluetooth headphones. As a consequence, a significant majority of participants admitted to missing road signs, potentially contributing to accidents.[18] This paper focuses on the evaluation of the effectiveness of road safety measures and their impact on the pattern and distribution of extracranial and intracranial hemorrhages in fatal head injuries. By exploring the impact of various road safety measures on the occurrence and severity of injuries, we aim to identify areas for improvement and develop effective strategies to enhance road safety and mitigate the impact of RTAs. Understanding the factors contributing to specific injury patterns can inform targeted interventions and policies to minimize the occurrence of severe injuries and fatalities in road accidents.

METHODOLOGY

Part of the methodology employed in this study was the selection of RTA cases with head injuries that were taken to the mortuary for a medico-legal postmortem examination. From April 2021 to March 2022, a complete year of the prospective study was conducted, during which 604 instances were discovered. The procedure comprises conducting interviews with these participants' companions using a predesigned structured questionnaire. The institutional ethical review board's approval and the subject attendant's informed consent were obtained before any information or data were collected.

Inclusion criteria

Encompass all fatal road traffic accident cases with head injuries.

Exclusion criteria

All cases other than road traffic accidents and crushed injuries.

RESULT

It is observed from Table 1 and also from Figure 1 that among the extracranial injuries, scalp abrasion

594 (98.34%) was found in the majority of fatal head injury cases. Scalp laceration, 563 (93.21%) out of 604 cases, was the second most common extracranial injury observed in our study. The least extracranial injury noted in the present study was scalp contusion, that is, 463 cases (76.66%) out of 604 total cases.

As per Table 2 and Figure 2, subdural hemorrhage 367 (60.76%) is the most common intracranial hemorrhage observed in the present study followed by subarachnoid hemorrhage 248 (41.06%) and intracerebral hemorrhage 195 (32.28%). Intraventricular hemorrhage 115 (19.04%) and extradural hemorrhage 112 (18.54%) were noted in almost a similar number of cases. The least number of intracranial hemorrhages observed was brain stem hemorrhage, that is, 54 cases (8.94%) out of 604 cases.

As per Table 3 and Figure 3, the combination of subdural hemorrhage and subarachnoid hemorrhage 131 (21.69%) was the most common combination of intracranial hemorrhage in fatal head injury due to road traffic accidents followed by subdural hemorrhage and intracerebral hemorrhage combination 105 (17.38%) and subarachnoid hemorrhage and intracerebral hemorrhage combination 80 (13.25%). The lesser common combinations were extradural hemorrhage and subdural hemorrhage combination 65 (10.76%), followed by extradural hemorrhage and intracerebral hemorrhage combination 37 (6.13%), followed by intraventricular hemorrhage and intracerebral hemorrhage combination 35 (5.79%), and extradural, subdural, and subarachnoid hemorrhage combination 24 (3.97%). The least number of combinations of intracranial hemorrhages were the combination of extradural, subdural, subarachnoid, and intracerebral hemorrhage 10 (1.66%) followed by a combination of extradural hemorrhage and intraventricular hemorrhage, that is, 23 cases (3.81%) out of 604 cases.

DISCUSSION

In a study conducted by Henderson, A *et al*. in 1992 to find out the prevalence of untreated life-threatening extracranial

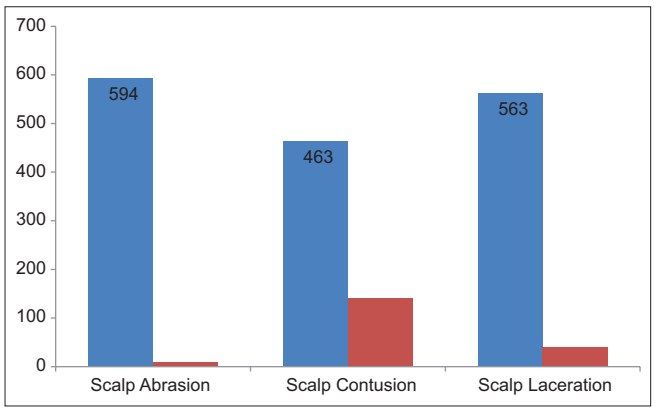

Figure 1: Pattern of distribution of extracranial injuries in fatal head injury cases due to road traffic accidents

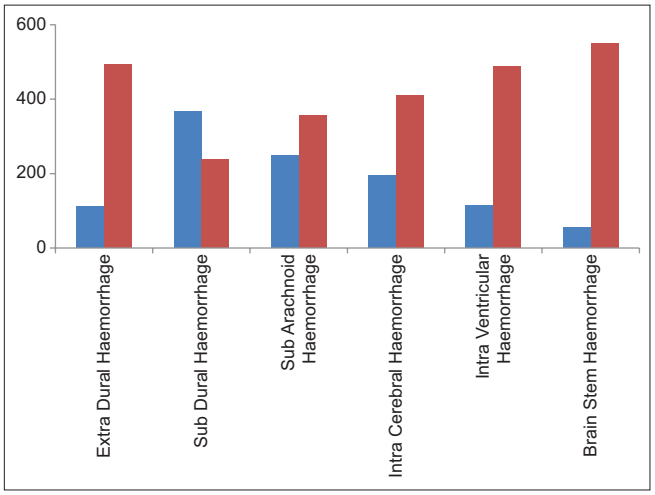

Figure 2: Pattern of distribution of intracranial hemorrhages in fatal head injury cases due to road traffic accidents

Table 1: The pattern of distribution of extracranial injuries in fatal head injury cases due to road traffic accidents (*n*=604)

Extracranial Injuries	Present	Percentage	Absent	Percentage	Total	Percentage
Scalp Abrasion	594	98.34%	10	1.66%	604	100.00%
Scalp Contusion	463	76.66%	141	23.34%	604	100.00%
Scalp Laceration	563	93.21%	41	6.79%	604	100.00%

Table 2: Pattern of distribution of intracranial hemorrhages in fatal head injury cases due to road traffic accidents (*n*=604)

Intracranial Hemorrhages	Present	Percentage	Absent	Percentage	Total	Percentage
Extradural Hemorrhage	112	18.54%	492	81.46%	604	100.00%
Subdural Hemorrhage	367	60.76%	237	39.24%	604	100.00%
Subarachnoid Hemorrhage	248	41.06%	356	58.94%	604	100.00%
Intracerebral Hemorrhage	195	32.28%	409	67.72%	604	100.00%
Intraventricular Hemorrhage	115	19.04%	489	80.96%	604	100.00%
Brainstem Hemorrhage	54	8.94%	550	91.06%	604	100.00%

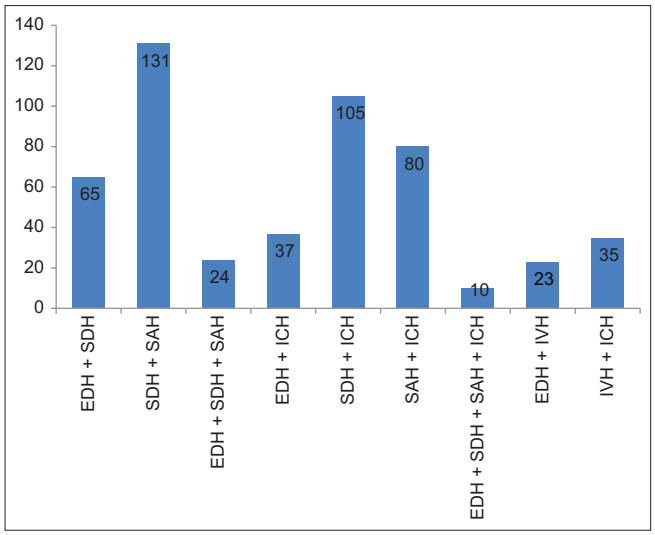

Figure 3: Type of combination of intracranial hemorrhages in fatal head injury cases due to road traffic accidents

Table 3: Type of combination of intracranial hemorrhages in fatal head injury cases due to road traffic accidents (*n*=604)

Combination of Intracranial Hemorrhages	No of Cases	Percentage
EDH + SDH	65	10.76%
SDH + SAH	131	21.69%
EDH + SDH + SAH	24	3.97%
EDH + ICH	37	6.13%
SDH + ICH	105	17.38%
SAH + ICH	80	13.25%
EDH + SDH + SAH + ICH	10	1.66%
EDH + IVH	23	3.81%
IVH + ICH	35	5.79%

injuries in patients transported to a large trauma center due to head injury, 12-month prospective research was conducted. Of the 43 patients that were transported, four (9%) had an untreated extracranial injury that was life-threatening and that resulted in death in two individuals (15 with an isolated head injury and 28 with multiple injuries).[19]

In another study conducted by Sukanya P. *et al.*, out of the 172 linear skull fractures, 99 were caused by RTA, followed by 32 by falls of unknown causes and 32 by RTA falling from a two-wheeler. In each of these cases, a head injury accompanied by a skull fracture, intracranial hemorrhages or brain damage was the direct cause of death.[20]

There were 60 (63.8%) men and 30 (36.2%) females among the 94 cases. The included patient had a mean age of 31.45 13.43 years and a mean BMI of 22.19 20.48. Fourteen (14.9%) of the deceased had an intracranial lesion. We discovered that the incidence of traumatic cases was greater than the frequency of nontraumatic (cerebrovascular accidents). In 31 (32.9%) instances, only intracranial lesions could be discovered. The most common cerebral pathology was hemorrhages in the subarachnoid space. Pneumonia is the most common reason for delayed death.[21]

The overall number of fatal head injury cases has been shown to decrease as a result of the introduction of road safety measures. This is consistent with global trends shown in the beneficial benefits of road safety programs in lowering the number of fatalities from traffic accidents.[22] Extracranial hemorrhages have significantly decreased since road safety measures have been put in place, according to analyses of these incidents. Improved road infrastructure, such as carefully designed highways and pedestrian crossings, which reduce the possibility of high-impact crashes, can be associated with this decrease.[23] There are many reasons why extracranial hemorrhages have decreased in fatal head injury cases since being adopted. A key factor in lowering high-impact collisions is improved road infrastructure, which includes better road design, traffic lights and pedestrian facilities. Reduced events involving pedestrians or other vulnerable road users result from safer road conditions, which lower the risk of serious extracranial hemorrhages.[24] The study's findings emphasize how essential rapid medical attention is for preventing intracranial hemorrhages. Even in cases of accidents, prompt medical attention can make a big difference in the result. To lessen the severity of cerebral hemorrhages and increase survival rates, access to healthcare facilities is essential, especially those that are set up to handle head injuries.[25]

CONCLUSION

In conclusion, the data reveals that scalp abrasion is the most common extracranial injury, while subdural hemorrhage is the most prevalent intracranial hemorrhage in fatal head injury cases from road traffic accidents. Evaluation of road safety measures is necessary to effectively reduce these injuries and their impact. Enhancing awareness and implementing preventive strategies can mitigate the devastating consequences of such accidents.

The results of an analysis of road safety initiatives in Uttar Pradesh, India, show that these initiatives have a real impact on lowering fatal head injuries and changing the distribution of extracranial and intracranial hemorrhages. The analysis emphasizes the critical importance of comprehensive road safety programs, including improvements to infrastructure, educational outreach, and strict law enforcement, in creating safer road conditions. More expenditures in these strategies are necessary to reduce the burden of traffic-related injuries in the area.

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Conflicts of interest

There are no conflicts of interest.

Ethical clearance

Ethical Clearance was obtained from Institutional Ethical Committee with Ref no ECR/922/inst/UP/2017 dated 23/07/2021. The institutional ethics committee of the hospital gave its approval to the study protocol. All participants provided informed consent before the data was collected. It was promised to participants that their answers would be kept private and anonymous.

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