Types of Traumatic Head Injury in Pedestrians and Cyclists

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I. INTRODUCTION

In 2023, Japan witnessed a total of 2,678 traffic fatalities, with pedestrian fatalities representing the highest proportion at 973 (36.3%) [1]. The proportion of pedestrian fatalities has increased in recent years. Of the total fatalities, cyclists accounted for 346 (12.9%) fatalities. Pedestrian and cyclist fatalities comprised 49.2% of the traffic fatalities [1]. Head injuries are the most common cause of death among pedestrians and cyclists [2]. Therefore, it is imperative to investigate the characteristics of traumatic head injuries caused by traffic accidents to develop countermeasures to reduce the fatalities of pedestrians and cyclists. This study aimed to clarify the types of traumatic head injury experienced by pedestrians and cyclists transported to medical emergency centres in Japan.

II. METHODS

This study analysed the types of traumatic head injury in pedestrians and cyclists using emergency patient data (EPD) obtained from the Medical Emergency Center of Dokkyo Medical University Saitama Medical Center, Japan. Dokkyo Medical Emergency Center is one of six medical emergency centres in Saitama Prefecture. Emergency patient data from October 2003 to December 2014 were analysed. The EPD contains information on patient sex, age, external cause of injury, disease name, diagnoses, and severity of injury. During the 11-years-and-three-month period from 2003 to 2014, the Dokkyo Medical Emergency Center accepted 1,056 emergency patients due to traffic accidents. In the accepted 1,056 emergency patients, 29% (304) were women and 71% (752) were men. Figure 1 shows the accident type observed in the patients transported to the medical emergency centre because of a traffic accident. Of the 1,056 emergency patients, the highest proportion of emergency patients were motorcycle riders, comprising 29% (311) of the total, followed by cyclists at 22% (231), pedestrians at 19% (195), and vehicle occupants at 17% (184). Additionally, there were 118 (11%) cases where the accident type remained unidentified.

We investigated the types of traumatic head injury in pedestrians and cyclists. This study included injuries sustained by pedestrians in vehicle-to-pedestrian and cyclists in vehicle-to-cyclist and single-cyclist crashes. The data used in the present study were approved by the ethical committee of the Dokkyo Medical University Saitama Medical Center.

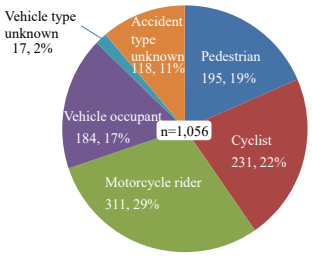

Fig. 1. Accident types of patients transported to the medical emergency centre due to traffic accidents.

III. INITIAL FINDINGS

Of the 195 pedestrians transported to a medical emergency centre after a traffic accident, 116 (59%) had traumatic head injuries. Because one pedestrian had multiple traumatic head injuries, such as skull fractures and subarachnoid haemorrhages, 116 pedestrians had 168 traumatic head injuries in total, which showed that the

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average number of traumatic head injuries per pedestrian was 1.45. Table I shows the traumatic head injury rankings from 1st to 5th among 168 traumatic head injuries. Rankings 1–5 account for 77% of the total. Among pedestrians with traumatic head injuries, the top three injury types were subarachnoid haemorrhage (23%), skull fracture (18%) and brain contusion (14%), accounting for 55% of the total.

Of the 231 cyclists transported to a medical emergency centre after a traffic accident, 138 (60%) had traumatic head injuries. A total of 138 cyclists experienced 212 traumatic head injuries, and the average number of traumatic head injuries per cyclist was 1.54. Table II shows the traumatic head injury rankings from 1st to 5th of the 212 traumatic head injuries. Rankings 1–5 account for 73% of the total. Among cyclists with traumatic head injuries, the three most common injury types were skull fracture (19%), subarachnoid haemorrhage (17%) and brain contusion (14%), accounting for 50% of the total. As described above, the top three traumatic head injuries among pedestrians and cyclists were the same: subarachnoid haemorrhage, skull fracture, brain contusion.

TABLE I Number and rate of traumatic head injury type in 116 pedestrians

Rank	Traumatic head injury type	Number	Rate
1	Subarachnoid haemorrhage	39	23
2	Skull fracture	30	18
3	Brain contusion	24	14
4	Subdural haematoma	23	14
5	Scalp laceration and head soft tissue injury	14	8
6 or less	Others	38	23
Total		168	100

TABLE II Number and rate of traumatic head injury type in 138 cyclists

Rank	Traumatic head injury type	Number	Rate
1	Skull fracture	40	19
2	Subarachnoid haemorrhage	36	17
3	Brain contusion	30	14
4	Subdural haematoma	28	13
5	Epidural haematoma	10	5
5	Concussion	10	5
7 or less	Others	58	27
Total		212	100

IV. DISCUSSION

The initial analyses presented here revealed that the top four traumatic head injuries in pedestrians and cyclists were subarachnoid haemorrhage, skull fracture, brain contusion and subdural haematoma. The same type of traumatic head injury ranked in the top four injuries for both pedestrians and cyclists. The top four traumatic head injuries occurred in 69% of pedestrians and in 67% of cyclists. As the mechanisms of traumatic head injury may be similar, implementing passive safety countermeasures may have a positive effect on both pedestrians and cyclists. Further studies are required to compare the present dataset with a more recent crash dataset to assess the effectiveness of vehicle crash safety developments in reducing cyclist/pedestrian fatalities.

The results of the present study revealed that the incidence of skull fracture was highest among cyclists and second highest among pedestrians. The relatively high travelling speed of bicycles may contribute to the higher occurrence of skull fractures among cyclists. Wearing a helmet can be a countermeasure to protect the heads of cyclists. A previous study showed that wearing a helmet greatly reduced the head injury criterion (HIC) in head collisions with a relatively higher-stiffness part of a vehicle, such as an A-pillar, or road surface [3]. In Japan, a revised road traffic law was enforced in April 2023, in which cyclists of all ages were required to make an effort to wear a helmet while riding a bicycle. This means that the revised road traffic laws were in place *after* the data period analysed in the present study; the traumatic head injuries observed in the present study would have been induced by fewer cyclists wearing helmets. The possibility of skull fractures in future traffic accidents is expected to decrease if cyclists are wearing helmets. However, the effects of wearing helmets on the prevention of brain injury remain unclear. In the future, it will be necessary to clarify the effects of cyclists wearing helmets on the occurrence of traumatic injuries.

V. ACKNOWLEDGEMENTS

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VI. REFERENCES

[1] National Police Agency, Traffic accident status, 2024.
[2] ITARDA, Traffic Statistics, 2023.
[3] Matsui, Y., *et al*., *Traf Inj Prev*, 2018.