Crash characteristics of helmeted motorcyclists

McIntosh, A.S[1], Pang, T.Y.[1], Thai, K.[1], Schilter, E.[1], Rechnitzer, G.[2], Finch C.F.[3], McCrory, P.[4]
[1]School of Risk and Safety Sciences, The University of New South Wales
[2]Delta-V Experts, Melbourne, Australia
[3] School of Human Movement and Sport Sciences, University of Ballarat
[4]Centre for Health, Exercise & Sports Medicine, Melbourne University

Abstract

The preliminary results of a prospective study of motorcycle crashes are reported. Motorcyclists were recruited from three major trauma centres in Sydney and through motorcycle organisations. The main sample criteria were that the cyclist crashed, and that they hit their head while wearing a helmet. Injury and non-injury cases were collected. Case sampling occurred over a period of 18 months. The response rate through hospitals was approximately 14% for those meeting the selection criteria. All motorcyclists were interviewed and the helmets were examined. Characteristics such as environment (road type), vehicle (vehicle damage and interaction) and human factors were recorded. The location of helmet impacts and patterns of helmet damage were recorded. Injuries were documented and rated according to severity. The relationships between the crash characteristics, helmet use and injury will be presented.

Introduction

It is mandatory for motorcyclists in Australia to wear a helmet and for those helmets to meet an approved standard [1]. The U.S. National Highway Traffic Administration reported that in 2004 motorcycle riders had a 34 times greater risk of being killed in a crash compared to passenger car occupants, after adjusting for distance travelled[2]. A range of human, environment and equipment factors have been identified as contributing to the crashes, their severity and the severity of the motorcyclists' injuries, eg. speed, age of motorcyclist, intoxication, time of day, conspicuity, risk taking behaviour, road side environment (poles/trees) and helmet use [2 3 4 5]. The focus of our study is to assess how well current helmets, and the standards that underpin their design and performance, are performing in real world crashes. Issues that have been raised as contributing to helmet performance are: fit, restraint system, energy attenuation, helmet style (full face vs. open face) and load distribution. Discrete biomechanical and testing issues include assessment of angular acceleration and the role of the resistance to penetration test in the standard [6 7 8].

This paper reports on the crash characteristics of motorcycle cases investigated to date in the study. This is the first paper describing this data set, currently in a preliminary phase of completion, and the results may differ marginally from future papers on this topic as they become finalised. The results are being used to study motorcycle helmet performance via in-depth biomechanical crash reconstructions in combination with other integrated studies on helmet ergonomics and test methods.

Methods

Motorcyclists and pedal cyclists* were recruited from three trauma centres in the Sydney Metropolitan Area and through advertising on-line and in print media. St. George, Liverpool and Royal North Shore Hospital trauma groups assisted in the recruitment of participants by identifying potential participants and either speaking to them directly about the study or sending a flyer. Fatal crashes were also investigated but are not reported in this paper. Interested motorcyclists were invited to contact the research team at UNSW. Motorcyclists could also register their interest on-line. The inclusion criteria were that the participant had been involved in a motorcycle crash while riding and wearing a helmet, received a head impact, and that their helmet was available for inspection. The injury outcome was not an inclusion criterion. The study was approved by institutional ethics committees. All participants or their representative provided informed written consent.

* This paper reports only on motorcyclists. Pedal cyclist results are presented in a companion paper.

Each participant was interviewed using a standard protocol. Where possible the helmet was collected, and if not, inspected, measured and photographed. Medical records relevant to the case were retrieved. Injuries and their severity were coded according to the Abbreviated Injury Scale (AIS) 2005 Revision.[9]

During the interview information on the motorcyclist's demographics, crash characteristics, injury outcome, helmet, and motorcycle were collected. The location of the crash was investigated and other information, eg. photographs of vehicle damage, was collected.

In this paper a descriptive analysis of the data set will be presented. The population demographics, crash characteristics and injury outcomes will be presented.

Results

This paper reports on 60 cases. All participants were wearing a motorcycle helmet at the time of the crash and experienced an impact to the head (helmet). Fourteen percent of cyclists invited by the three hospitals to participate in the combined pedal and motorcycle helmet studies responded and were suitable for inclusion in the study. The majority (93%) of participants were male. Thirty-three percent of participants were aged between 20 and 34 years and 53% between 35 and 54 years. Ten percent of motorcyclists had less than one year of experience, 20% had two to five years experience and 70% had more than five years riding experience. Twelve percent (12%) of motorcyclists were either uninjured or received first aid only, 29% were treated at hospital and 59% were admitted because of the severity of their injury/s. The majority of motorcyclists (74%) had no head injury and 21% experienced an AIS 2 or 3 head injury (Table 1). The upper and lower limbs of motorcyclists were injured in approximately 70% of cases, with 40% of upper limb injuries at an AIS 2 level. The most severe injuries were experienced at the thorax.

Table 1: Distribution of injuries by body region and severity

MAIS	Head	Neck	Thorax	Abdomen	Spine	Upper Limb	Lower Limb
0	74.1%	86.2%	70.7%	86.2%	93.1%	31.0%	27.6%
1	5.2%	12.1%	10.3%	8.6%	0%	27.6%	53.4%
2	15.5%	1.7%	3.4%	3.4%	6.9%	39.7%	15.5%
3	5.2%	0.0%	13.8%	1.7%	0.0%	1.7%	3.4%
4	0.0%	0.0%	1.7%	0.0%	0.0%	0.0%	0.0%

The distribution of the cases by crash type was largely bimodal: 49% of crashes were single vehicle and 39% involved another moving vehicle. The specific crash configuration is provided in table 2

Table 2: Crash configuration

Crash Configuration	Frequency	%
On straight, off roadway to left or right	1	1.7%
On straight, lost control on roadway	11	18.6%
On bend, off roadway to left or right	13	22.0%
Jump, lost control, bad landing	1	1.7%
On straight, off roadway to left or right into object	2	3.4%
Vehicles from adjacent approaches (intersection)	6	10.2%
Vehicles from opposing directions	4	6.8%
Vehicles from same direction	12	20.3%
Other	9	15.3%
Total	59	100%

Discussion

This is the first analysis of this crash case data set of motorcycle crashes in which the motorcyclist wore a helmet. The relationship between helmet design, performance and injury outcome will be the focus of the main analyses; to be presented in the future.

The motorcycle rider population recruited was primarily an adult male population. Half of the crashes were single vehicle, which is consistent with findings from other research. A third of crashes involved a second moving vehicle.

Three-quarters of the motorcyclists did not suffer a head injury, despite being struck on the head. All were wearing a helmet. The upper and lower extremities experienced AIS 1 and 2 injuries. Seventy percent of motorcyclists did not have thoracic injuries, however 16% had AIS 3 or 4 injuries. The thorax was the body region with the largest proportion of the highest severity injury.

The results strongly indicate the benefits offered by wearing a helmet and support the findings of previous helmet research. It is acknowledged that there are limitations with the dataset, however the data will be applied to study specific helmet characteristics after accounting for the impact dynamics. The results of these analyses will be presented in future reports.

Conclusions

The majority of helmeted motorcyclists did not experience a head injury, despite being exposed to a head impact, however 5.2% of the sample still received a MAIS 3 head injury. These results will be used as part of the broader study to examine possible improvements to motorcycle helmet performance [and standards] to reduce serious head injury risk further. Injuries to the upper and lower limbs and serious injuries to the thorax warrant further investigation in terms of causation and prevention.

Acknowledgments

This work has been conducted by the University of New South Wales, School of Risk and Safety Sciences under funding by an Australian Research Council (ARC) Linkage Grant LP0669480 *Pedal and Motor Cycle Helmet Performance Study.* The project partners are: the Department of Infrastructure, Transport, Regional Development and Local Government; Road Traffic Authority (NSW RTA); Transport Accident Commission (TAC Victoria); NRMA Motoring & Services; NRMA-ACT Road Safety Trust; and DVExperts International. This paper does not represent the views of any of these organisations. Caroline Finch was supported by an NHMRC Principal Research Fellowship.

The authors thank and acknowledge the support provided by staff at St. George, Liverpool and Royal North Shore Hospitals, in particular Kate Curtis, Tiffany Rankin, Erica Caldwell, Sarita Karanth, Dr. Tony Joseph, and Meredith Potter and Erica Caldwell. We would also like to acknowledge the support of the Motorcycle Council of NSW.

References

[1] AS/NZS1698:2006, Protective helmets for vehicle users, Jointly published by Standards Australia and Standards New Zealand,, Sydney and Wellington, 2006.

[2] NHTSA, Traffic Safety Facts, 2005 Data, Motorcycles. DOT HS 810 620, 2005

[3] Quddus, M. A., Noland, R. B., & Chin, H. C. An analysis of motorcycle injury and vehicle damage severity using ordered probit models. Journal of Safety Research, 2002; 33: 445-462

[4] Lin, M. R., & Kraus, J. F. A review of risk factors and patterns of motorcycle injuries. Accident Analysis & Prevention, 2009: 41: 710-722

[5] Haworth, N., Smith, R., Brumen, I., & Pronk, N. Case Control Study of Motorcycle Crashes Canberra, Australia: Department of Transport and Regional Development, 1997

[6] M. Aare and P. Halldin, A new laboratory rig for evaluating helmets subject to oblique impacts, Traffic Injury Prevention, 2003; 4: 240-248

[7] P. Halldin, A. Gilchrist, and N. J. Mills, "A new oblique impact test for motorcycle helmets," IJCrash, 2001; 6: 53-64

[8] Dowdell B, Long GJ, Ward J, Griffiths M. A study of helmet damage and rider head/neck injuries for crash-involved motorcyclists. Road Safety Bureau Research Note 5/88 RTA Crashlab, 1988.

[9] AAMA. Abbreviated Injury Scale 2005 Revision Des Plaines,Illinois, 2005