COMPARISON OF HEAD AND OTHER INJURIES IN MELBOURNE PEDAL AND MOTOR CYCLIST CASUALTIES

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ABSTRACT

Safety helmet wearing is compulsory for motor cyclists in Australia. There is no compulsion for pedal cyclists to wear helmets and few do. Concern regarding the frequency of head injury among pedal cyclist casualties (PCC) has led us to compare the injury profile of 512 PCC and 667 motor cyclist casualties (MCC) treated between 1977-80 at four major Melbourne Hospitals. Their medical records were reviewed and injury data analysed using the Abbreviated Injury Scale (1980 revision). Comparisons were made between casualties involved in collisions with another vehicle, in single vehicle accidents and between casualties aged 17 years or more.

The fatality rates of PCC and MCC were 2.3% and 1.4%, respectively. Of PCC, 2.0% died from head injury alone compared to 0.8% of MCC. PCC sustained more frequent (59% *versus* 26%) and severe (A.I.S. $\geq$ 3) head injury (9% *versus* 4%) ($P < 0.001$). However, with the exception of single vehicle accident casualties, the maximum level of injury to any part of the body

(maximum A.I.S.) was greater in MCC ($P < 0.01$).

These differences may be explained, at least in part, by the fact that all MCC were wearing helmets whereas the wearing rate for PCC was less than 5%. The Road Trauma Committee of the Royal Australasian College of Surgeons is presently seeking legislation for compulsory wearing of approved safety helmets by PCC.

INTRODUCTION

A comprehensive pattern of injury study was undertaken between 1971-73 by the Road Trauma Committee of the R.A.C.S.[1] This study was principally directed at analysis of the influence of seat belt wearing on vehicle occupant injuries. Relatively little information has been reported in Australia on pedal cyclist accidents. The Adelaide Indepth Study, (1975-79)[2] was limited to 22 pedal cyclists and 80 motor cyclists. Head injuries were almost three times more frequent among the pedal cyclist casualties. Two-thirds of the pedal cyclist accidents occurred on arterial roads and were a consequence of errors made equally by the cyclists and the drivers.

An evaluation of the injury data collected between 1975-80 by the Motor Accidents Board of Victoria showed that concussion, intracranial injury and fractures of the vault and base of the skull were significantly more frequent among pedal compared to motor cyclist casualties[3]. However, the data sources were incomplete and it was evident that further study based on complete and accurate data was required involving a larger sample of casualties than that investigated in the Adelaide Indepth Study.

This paper presents the results of a pattern of injury study based on examination of the hospital medical records of 512 pedal and 667 motor cyclist casualties managed during 1977-80 at four Melbourne teaching hospitals.

PATIENTS AND METHODS

Listings of all pedal and motor cyclist casualties managed between 1st July, 1977 and 30th June, 1980 at four Melbourne teaching hospitals were obtained from the Motor Accident Board of Victoria and the Road Traffic Authority. The Motor Accident Board listings did not include casualties whose cost of treatment was less than $A100.00 or pedal cyclist casualties involved in single vehicle accidents. The Road Traffic Authority listings included all pedal and motor cyclist casualties reported to Police and treated at the four hospitals.

Permission was obtained from the hospitals to review the medical records of pedal (male: 431; (84.2%), female: 81; (15.8%)) and motor cyclists (male: 620; (93.0%); female: 47; (7%)) casualties managed between 1st July, 1977 and 3rd June, 1980 as in —

or outpatients at Alfred Hospital (pedal: 200; motor: 344), Preston and Northcote Community Hospital (pedal: 119; motor: 160) at St. Vincent's Hospital (pedal: 46; motor: 160) Royal Children's Hospital (pedal: 147; motor: 3). Pillion passengers were excluded. Of the 512 pedal cyclist casualties 117 (22.9%) were aged less than 10 years, 235 (45.9%) 10-16 years, 100 (19.5%) 17-25 years and 60 (11.7%) more than 25 years. Of the 667 motor cyclist casualties, 14 (2.1%) were less than 17 years of age, 538 (80.7%) 17-25 years of age and 115 (17.2%) more than 25 years. The licensing age for motor cyclists in Victoria is 18 years. Approximately, one-fifth of the casualties treated required inpatient admission.

Injuries were coded according to the 1980 revision of the Abbreviated Injury Scale (A.I.S.) of the American Association for Automotive Medicine[4] in a format suitable for analysis using the Statistical Package for the Social Sciences[5]. Comparisons made between the pedal and motor cyclist casualties included:

1) Survival and cause of death.
2) Injury sites and A.I.S. severity of injury.
3) Head injury frequency and severity.
4) The maximum severity of injury sustained to any region of the body (maximum abbreviated injury score).
5) The injury severity score (I.S.S.) i.e. the sum of the squares of the three most severe injuries sustained in different regions of the body[6].

The injury profiles of the following groups were also studied:

1) Pedal and motor cyclist casualties in accidents involving another vehicle.
2) Pedal and motor cyclist casualties involved in single vehicle accidents.
3) Pedal and motor cyclist casualties aged 17 years or more.
4) Pedal cyclists aged less than 17 years and those aged 17 years or more.

STATISTICAL ANALYSIS

Differences between the frequency of mortality and injury and between the frequency of severe and non-severe injury were assessed by the use of the Chi-squared test. Severe injuries were defined as those equal to or greater than severity level 3 in the Abbreviated Injury Scale (A.I.S.). Severe injury severity scores were defined as those equal to or greater than nine. Differences between the ranking of A.I.S. severity injury levels were assessed by the Mann Whitney test (2-tailed). Probability values less than 5% were considered statistically significant.

RESULTS

Fatalities

The fatality rates of pedal and motor cyclist casualties were 2.3% and 1.4%, respectively. Compared to 0.8% of motor cyclist

casualties, 2.0% of pedal cyclist casualties died from head injury alone. A further 0.2% of pedal and 0.5% of motor cyclist casualties died from multiple injuries including head injury. These differences did not attain statistical significance.

INJURIES

Findings are detailed in Table 1. Head injuries occurred in 58.8% of pedal and 26.1% of motor cyclist casualties ($P < 0.001$). Severe head injuries occurred in 9.1% and 3.8% ($P < 0.001$), respectively. A.I.S. levels were also ranked greater in pedal cyclists casualties ($P < 0.001$). Injuries to the vault of skull occurred in 5.7% of pedal and 1.2% of motor cyclist casualties ($P < 0.001$); severe skull vault injuries occurred in 2.0% and 0.2% respectively ($P < 0.01$) and A.I.S. levels were greater in pedal cyclist casualties ($P < 0.001$). The level of unconsciousness was significantly greater in pedal cyclist casualties and facial injuries were more frequent and severe. However, abdominal and pelvic content and extremity/pelvic girdle injuries were more frequent in motor cyclist casualties. A greater proportion of motor cyclist casualties sustained an injury of A.I.S. ≥ 3. Injury severity scores did not differ isgnificantly but a greater proportion of motor cyclist casualties had high scores (≥ 9). The injury pattern of male and female pedal cyclist casualties did not differ significantly. Male compared to female motor cyclist casualties had higher injury severity scores and high socres were more frequent.

PEDAL AND MOTOR CYCLIST CASUALTIES INVOLVED IN COLLISIONS WITH ANOTHER VEHICLE

Differences between 474 pedal and 428 motor cyclist casualties are detailed in Table 2. Pedal cyclists sustained more frequent and severe head injury. A vault of skull injury occurred in 6.3% of pedal and 0.7% of motor cyclist casualties ($P < 0.001$); severe skull vault injuries occurred in 2.2% of pedal but were absent in motor cyclist casualties ($P < 0.05$). A.I.S. levels were also greater in pedal cyclist casualties ($P < 0.001$). Cerebral/ cerebellar injury occurred in 3.4% of pedal and 0.7% of motor cyclist casualties ($P < 0.01$); severe injury occurred in 2.1% and 0.2%, respectively ($P < 0.001$) and A.I.S. levels were greater in pedal cyclist casualties ($P < 0.01$). Levels of unconsciousness were more frequently severe and facial injuries more frequent in pedal cyclist casualties. Motor cyclist casualties sustained more frequent and severe injuries to the extremities and pelvic girdle. A greater proportion of motor cyclist casualties had A.I.S. of ≥ 3.

PEDAL AND MOTOR CYCLIST CASUALTIES IN ACCIDENTS NOT INVOLVING ANOTHER VEHICLE

The injury profiles of 38 pedal and 239 motor cyclist casualties in accidents not involving another vehicle are detailed in Table 3. Pedal cyclists had more frequent head and facial injury

and greater A.I.S. severity levels. Abdominal injury was more frequent and severe in motor cyclist casualties. The maximum A.I.S. and I.S.S. did not differ significantly between these groups.

PEDAL AND MOTOR CYCLIST CASUALTIES AGED 17 YEARS OR MORE

Differences between 160 adult pedal and 653 motor cyclist casualties are given in Table 4. Head injuries were more frequent & A.I.S. levels greater in pedal cyclists.

Vault of skull injuries were also more frequent ($P < 0.05$). Facial injuries were more frequent in pedal cyclist casualties but motor cyclists had more frequent injuries to the abdomen, extremities and pelvic girdle, and a significantly greater proportion sustained a maximum A.I.S. ≥ 3.

PEDAL CYCLIST CASUALTIES AGED LESS THAN 17 YEARS COMPARED WITH THOSE AGED 17 YEARS OR MORE

Findings in 352 pedal cyclist casualties less than 17 years of age and 160 aged 17 years or more are detailed in Table 5. Head injury was more frequent and severe in pedal cyclists less than 17 years of age. The younger age group had more frequent abdominal injury. The maximum A.I.S. did not differ significantly but injury severity scores were greater in the younger age group.

DISCUSSION

This investigation based on analysis of the hospital medical records has shown that although motor cyclist casualties sustained more severe overall injury to the body than pedal cyclists, head and facial injuries were more frequent and severe among pedal cyclist casualties. These findings are explained at least in part by the fact that all motor cyclists were protected by safety helmets whereas few pedal cyclists were similarly protected. During the years investigated helmets were worn by less than 5% of pedal cyclists[7]. It is believed that the greater vulnerability of pedal cyclist casualties to head injury would be reduced by safety helmet wearing.

The injury profiles of pedal and motor cyclists involved in collisions with another vehicle followed this pattern of injury. Comparison of adult pedal with motor cyclist casualties again showed an over-representation of head and facial injuries among pedal cyclists although motor cyclist casualties sustained a greater maximum level of injury to any part of the body. In single vehicle accidents head and facial injuries were similarly more frequent in pedal cyclist casualties but there was no significant difference between the maximum level of injury sustained to any part of the body. The smaller number of pedal cyclist casualties involved in single vehicle accidents may be accounted for by a lower frequency of single vehicle accidents in pedal cyclists and/or pedal cyclists sustaining injury less

frequently than motor cyclists in such accidents.

The selection of casualties examined in the present study has a bias towards the exclusion of pedal and motor cyclist casualties with minor or trivial injury. It is known that many pedal cyclists sustain falls with minor injury which are not reported to Police and which do not require medical management e.g. minor abrasions and contusion of the extremities. It seems likely that a greater proportion of pedal than motor cyclist casualties sustain minor or trivial injury which does not require medical treatment. In addition, a small number of pedal and motor cyclist casualties sustaining minor injury would attend a local general practitioner rather than a hospital casualty department. Because major trauma units have not yet been established in the Melbourne metropolitan area, road casualties are taken by ambulance to the closest major public (teaching or non-teaching) hospital. The absence of special criteria for taking casualties to teaching hospitals, excludes bias in this regard.

The results of this investigation closely resemble those reported from analysis of the incomplete Motor Accidents Board and Road Safety Traffic Authority of Victoria records[3] and in the Adelaide Indepth Study[2].

Heightened community awareness of the need for head protection for pedal cyclists, the wider range of approved safety helmets now available at lower cost and appreciable adult wearing rates have provided a climate suitable for the introduction of legislation requiring compulsory helmet wearing by pedal cyclists. Prior to the introduction of legislation for compulsory seat belt wearing, seat belts had been worn by 20% of vehicle occupants. Analysis has shown that helmet wearing involving all pedal cyclists is likely to be cost beneficial to the community[8,9].

There has been increasing awareness in Victoria of the value of approved helmet safety wearing by pedal cyclists. The Road Trauma Committee of the Royal Australasian College of Surgeons has repeatedly drawn media attention to the high vulnerabiltiy of pedal cyclist casualties to head injury. The Committee has also written to all School Councils and Principals in Victoria recommending that children wear approved helmets. In 1984, the Road Traffic Authority of Victoria established a Task Force to assist in popularising helmet wearing. Many schools have now made the wearing of approved helmets compulsory for children riding to and from school.

In December 1984, the Minister of Transport, Mr. S. Crabb acceded to request form the Road Trauma Committee for $A10.00 Government rebate during the Christmas period to the purchasers of approved helmets. More than 37,000 were sold. In view of the success of this scheme, the Victorian Government will in the first place extend the rebate offer to the end of the financial year.

In January 1985, a survey of helmet usage by the Road Traffic Authority reported that wearing rates among adult pedal cyclists commuting on arterial roads had reached 42% compared to 24% in 1983. Whereas helmet wearing rates among primary and secondary school students were 10% and 5%, respectively in June 1984, their corresponding wearing rates in January 1985 reached 39% and 14%.

Legislation for mandatory helmet wearing by pedal cyclists is readily enforceable. It is envisaged that children who fail to comply with the legislation would be requested to attend the local police station with their parents where the matter can be discussed.

The Road Trauma Committee's advocacy of legislation for compulsory helmet wearing has the support of the Australian Medical Association, the Australian Brain Foundation, the Royal Automobile Club of Victoria and the wide community.

It is our view that this legislation would achieve a marked reduction in pedal cyclist fatality and permanent brain damage similar to that which followed legislation for compulsory helmet wearing by motor cyclists[11].

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REFERENCES

1. Nelson P. Pattern of Injury Survey of Automobile Accidents, Victoria, Austraila, June 1971 - June 1973. Melbourne, Royal Australasian College of Surgeons Road Trauma Committee.

2. McLean A, Brewer ND, Sandow BL. Adelaide In-depth Accident Study 1975 - 79: Part 3: Pedal Cycle Accidents. Part 4: Motor Cycle Accidents. University of Adelaide, Adelaide,1979.

3. McDermott FT, Klug GL. Differences in head injuries of pedal cyclist and motor cyclist casualties in Victoria. Med. J. Aust 1982; 2:30-32.

4. The Abbreviated Injury Scale 1980 Revision. Committee of Injury Scaling A.I.S.-80. Co-chairman: JD States and DF Huelke. American Association for Automotive Medicine, 1980.

5. Nie NH, Bent DH, Hull C. SPSS: Statistical Package for the Social Sciences. New York: McGraw-Hill, 1970.

6. Baker SP. The injury severity score: a method for describing patients with multiple injuries and evaluating emergency care. J Trauma. 1974; 14:187-196.

7. Road Safety and Traffic Authority of Victoria, Data 1983.

8. Social Development Committee. Parliament of Victoria. First Report upon Road Safety in Victoria. Government Printer, Melbourne, May 1984.

9. Dorsch MM, Woodward AJ, Somers RL. Effect of helmet use in reducing head injury in bicycle accidents. Proceedings of the Twenty-Eighth Conference of the American Association for Automotive Medicine, held at Denver, Colorado, October 8-10, 1984. pp. 247-259.

10. School bicycle helmet usage survey. Report, Road Traffic Authority, January, 1985.

11. Foldvary LA, Lane JC. The effect of compulsory safety helmets on motor-cycle accident fatalities. Aust. Road Res. 1964; 2:7-24.

Table 1. Injury profile of pedal (512) and motor (667) cyclist casualties

	Cyclist Casualty	Injury %	Severe Injury %	A.I.S. Levels
Head injury	Pedal	58.8***	9.1***	⇧***
	Motor	26.1	3.8	
- Vault of skull	Pedal	5.7***	2.0**	⇧***
	Motor	1.2	0.2	
- Unconscious	Pedal	4.3 *	4.3*	⇧*
	Motor	2.1	2.1	
Facial injury	Pedal	46.9***	N.S.	⇧***
	Motor	16.8		
Abdominal injury	Pedal	4.3 **	N.S.	⇩**
	Motor	8.4		
Extremity or pelvic girdle	Pedal	83.4***	13.1***	⇩***
	Motor	92.1	29.8	
Maximum A.I.S.	Pedal	-	24.6***	⇩**
	Motor	-	33.9	
I.S.S.	Pedal	-	31.1*	N.S.
	Motor	-	37.0	

*$P < 0.05$; **$P < 0.01$; ***$P < 0.001$. N.S. Not significant

A.I.S. Levels: ⇧⇩ significantly higher levels in PCC
⇩ significantly lower levels in PCC

Severe injuries are those with A.I.S. ≥ 3

I.S.S. severe injury: ≥ 9

Table 2. Injury profile of pedal (474) and motor (428) cyclist casualties involved in collision with another vehicle

	Cyclist Casualty	Injury %	Severe Injury %	A.I.S. Levels
Head injury	Pedal	59.7***	9.7***	⇧***
	Motor	25.7	3.0	
- Vault of skull	Pedal	6.3***	2.2*	⇧***
	Motor	0.7	0.0	
- Cerebral or cerebellar	Pedal	3.4 **	2.1**	⇧**
	Motor	0.7	0.2	
- Unconscious	Pedal	4.4 *	4.4*	⇧*
	Motor	1.9	1.9	
Facial injury	Pedal	47.5***	N.S.	⇧***
	Motor	16.6		
Extremity or pelvic girdle	Pedal	83.3***	12.6**	⇩***
	Motor	92.5	34.4	
Maximum A.I.S.	Pedal	-	24.7***	⇩**
	Motor	-	37.6	
I.S.S.	Pedal	-	N.S.	N.S.
	Motor	-		

*$P < 0.05$; **$P < 0.01$; ***$P < 0.001$

Table 3. Injury profile of pedal (38) and motor (239) cyclist casualties in single vehicle accidents

	Cyclist Casualty	Injury %	Severe Injury %	A.I.S. Levels
Head injury	Pedal	47.4*	N.S.	↑*
	Motor	26.8		
Facial injury	Pedal	39.5**	N.S.	↑**
	Motor	26.8		
Chest injuries	Pedal	N.S.	N.S.	↓*
	Motor			
Abdominal injuries	Pedal	N.S.	N.S.	↓*
	Motor			
Maximum A.I.S.	Pedal	-	N.S.	N.S.
	Motor	-		
I.S.S.	Pedal	-	N.S.	N.S.
	Motor	-		

*P < 0.05; **P < 0.01; ***P < 0.001

Table 4. Injury profile of pedal (160) and motor (653) cyclist casualties aged 17 years or more

	Cyclist Casualty	Injury %	Severe Injury %	A.I.S. Levels
Head injury	Pedal	48.1***	N.S.	↑***
	Motor	25.4		
- Vault of skull	Pedal	4.3*	N.S.	↑**
	Motor	1.2		
Facial injuries	Pedal	40.6***	N.S.	↑***
	Motor	16.2		
Abdominal injuries	Pedal	1.2**	N.S.	↓**
	Motor	8.4		
Extremity or	Pedal	85.6*	10.6***	↓***
pelvic girdle	Motor	92.3	29.6	
Maximum A.I.S.	Pedal	-	20.1***	↓**
	Motor	-	33.9	
I.S.S.	Pedal	-	26.9*	N.S.
	Motor	-	36.8	

*P < 0.05; **P < 0.01; ***P < 0.001

Table 5. Injury profile of pedal cyclists aged less than 17 (352) with pedal cyclists 17 years of age or more (160).

	Age Group	Injury %	Severe Injury %	A.I.S. Levels
Head injury	< 17	63.6***	11.0*	↑***
	⩾ 17	48.1	5.1	
- Unconscious	< 17	6.0*	5.7*	↑*
	⩾ 17	1.3	1.3	
Abdominal injuries	< 17	5.7*	N.S.	↑*
	⩾ 17	1.2		
Maximum A.I.S.	< 17	-	N.S.	N.S.
	⩾ 17			
I.S.S.	< 17	-	N.S.	↑*
	⩾ 17			

*$P < 0.05$; **$P < 0.01$; ***$P < 0.001$