MECHANISM OF LOWER LIMB INJURIES AMONGST MOTORCYCLIST CASUALTIES - PRELIMINARY FINDINGS

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ABSTRACT

Preliminary results from a study of motorcyclist casualties' leg injuries are reported, based on a cooperative study between the Transport and Road Research Laboratory (TRRL) and three neighbouring hospitals. New methodology was developed for this type of research which is fully described together with full collision details.

The aim was to establish detailed mechanisms of leg injuries for motorcyclist casualties admitted to the three participating hospitals as in-patients with lower limb fractures. The preliminary results indicate that a high proportion of the injuries are due to contact with car front structures as car-to-motorcycle accidents are the most common type of collision. Examination of clothing, particularly trousers, has enabled the precise location of leg contact to be established in a high proportion of cases. The part played by the motorcycle structure has also been examined in the study.

Preliminary results from 47 accidents are presented with injury severity and location details and the study is continuing. The final results will support TRRL's engineering programme on lower limb protection for motorcyclists and the methodology will be used for other motorcyclist injury studies.

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INTRODUCTION

Previous motorcyclist accident studies (1,2,3,4) have indicated that a high proportion of injuries are to the legs. Such injuries frequently lead to extended hospital stay with corresponding bed occupancy and related costs, and sometimes lead to permanent disability.

In support of TRRL's research programme on leg protection for motorcyclists, a study was set up in cooperation with three hospitals local to the Laboratory. The aim was to investigate the detailed mechanism of leg injuries sustained in the accident and this paper reports the preliminary findings.

METHODOLOGY

Only casualties whose leg injuries were severe enough to be admitted to the hospital wards were included in the sample. Several injuries to one casualty were sometimes observed and some fatally injured casualties were included when there had been a serious leg injury in addition to the other injuries. Of particular interest in the study were cases where there had been lower limb fractures with or without soft tissue and/or ligamental damage. Casualties with slight injuries were not included for practical reasons.

In contrast to previous studies which have largely depended on retrospective analysis of clinical and accident information, the current study has used refined investigative techniques. The notification of the accident and acquisition of clinical information took place soon after admission to hospital, the clinical staff involved in the study telephoning TRRL staff at the earliest opportunity when an accident of research interest had occurred. An injury proforma was completed, noting all injuries with particular emphasis on surface and skeletal leg injuries. Any recall by the rider of accident circumstances was also noted. The casualty's clothing was examined where possible which provided a profitable source of information on body contacts. The motorcycle, together with any other vehicle involved or structure contacted, were examined at the earliest opportunity, all damage being noted and photographs taken. Any leg contacts on either the motorcycle or contacted vehicle/structure were also noted and other evidence such as pre-accident vehicle manoeuvres and collision speeds were obtained where possible, usually from police sources.

RESULTS

The number of motorcyclist casualties treated at two of the hospitals involved in the study have been monitored over the period of the study considered in this preliminary report. The information is presented in Table 1.

TABLE 1

Motorcyclist casualties attending two district hospitals March - December 1983

Total M/C casualties attending	In-patients	Admitted for leg injury	Number in sample
612	138	67	50

(Includes 2 fatalities with leg injuries. Some leg injuries were minor with only 24 hours length of stay)

It can be seen that not all casualties admitted with leg injuries were included in the sample. This is due to a variety of reasons including absences of the staff involved in the study, casualties not meeting the criteria, clinical priorities overriding other factors etc. The above figures also include two fatalities although these were not generally included.

Full information has been obtained for 50 casualties from 47 accidents. The age distribution is shown in Table 2 and the rider/pillion distribution in Table 3.

TABLE 2

Age distribution

Age (years)	16	17	18	19	20	21	22	23	24	25	26-30	>30	NK	Total
N	7	6	6	6	4	0	1	2	1	1	5	4	7	50

TABLE 3

Rider/Pillion distribution

Rider	Pillion
45	5

The distribution of accidents in relation to speed limits is given in Table 4 and the collision location related to junctions in Table 5.

TABLE 4

Urban/Rural distribution

Speed limit	≤40 mile/h	>40 mile/h*
N	26	21

(40 mile/h = 64 km/h)

*including motorways

TABLE 5

Collision location

Junction/r'bout	Non-junction
28	19

Engine size distribution is given in Table 6.

TABLE 6

(Capacities in cc)

50 Moped	Step thru (all capacities)	51-125	126-200	200-400	400	Total
6	5	13	5	10	8	47

The vehicle/object struck by or vehicle striking the motorcycle in the accident is given in Table 7.

TABLE 7

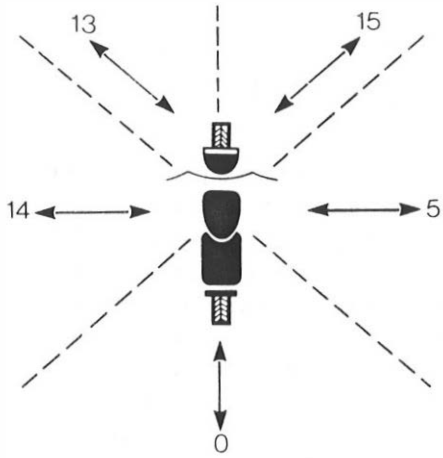
Impact configurations

	Saloon car	HGV/LGV/PSV	Solid object	Road surface
M/C struck	25	5	1	4
M/C struck by	11	1	-	-
Total	36	6	1	4

The direction of initial impact to the motorcycle is shown in Figure 1.

Fig. 1

Direction of initial impact



Location of principal leg contacts are shown in Table 8. In some cases the leg was trapped but in others the principal injury was caused by sole contact to a structure, either on the motorcycle or structure contacted. 'Flat panels' include car wings and door panels.

TABLE 8

Structure involved in principal leg injury

Other structure / On M/C	Flat panel	Reinforced panel	Vehicle corner	Grill/ Bumper	Solid object	Road surface	Sole contact	Total
Tank	3	-	-	2	-	-	-	5
Handlebar	-	-	1	2	-	-	6	9
Crashbars	-	-	-	-	-	-	1	1
Fairing	-	-	-	-	-	-	1	1
Engine block	2	-	-	-	-	-	-	2
Gearbox etc	3	-	1	3	-	-	-	7
Frame	-	-	3	2	-	-	-	5
Other	-	-	4	-	-	1	-	5
Sole contact	8	1	1	6	1	3		19
Total	18	1	10	13	1	4	8	55

TABLE 9

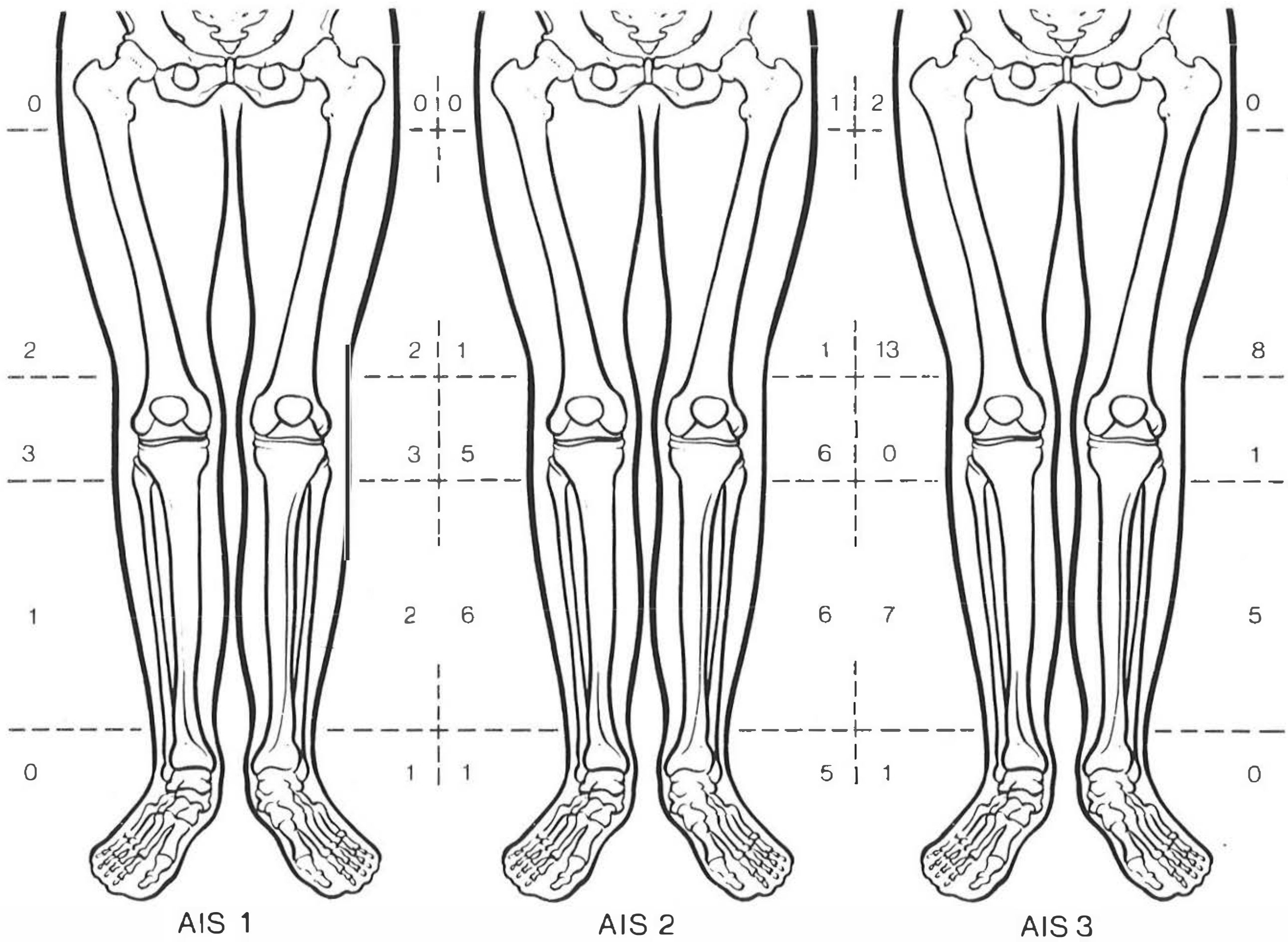
Approximate total collision speed distribution
(based on witnesses'/drivers' estimates)

Speed miles/h	<20	21-30	31-40	41-50	>50	NK	Total
N	3	11	16	8	5	4	47

The total number of significant leg injuries sustained by the casualties is shown in Figure 2. The Abbreviated Injury Scale has been used as an indicator of severity for each leg region (as shown). Therefore a right femur fracture and a left knee laceration on one casualty would be shown as two separate injuries and indicated accordingly on the appropriate diagrams. Minor lesions have not been included and the majority of AIS 1 injuries were lacerations. Tibial and fibula fractures occurring together have been recorded as one injury and lacerations at a fracture site have not been recorded or coded separately. Pelvic girdle injuries have been excluded from the sample.

Fig. 2

Number of significant injuries per leg region according to severity



DISCUSSION

It is observed that, of the total number of in-patients, 49 per cent were admitted with leg injuries of which a substantial proportion were included in the sample. Injuries to the latter group varied from deep lacerations to compound/comminuted fractures requiring major surgery and extended in-patient care followed by attendance at out-patient clinics. In keeping with national trends and similar studies, a high percentage in the sample were under 21 years of age. The predominance of rider injuries compared to those sustained by pillion passengers obviously reflects the fact that the majority were solo riders. However, when pillion passengers were present, there was a suggestion that their added body weight contributed to the severity of rider injuries in frontal collisions but more data are required for a more positive correlation.

Tables 4 and 5 relating to the locations of the accidents suggest that these do not differ significantly from national data. The majority of urban accidents involved a junction and, although some non-urban accidents in the sample also involved junctions, speed played a part in accidents in these areas. Larger engine capacity machines featured significantly and a high proportion of all accidents involved collisions with saloon cars, particularly at junctions. As shown in Figure 1, the majority of the impacts were to the front and nearside of the motorcycle which confirms previous findings(2).

Although the present sample size is too small to draw any detailed conclusions, a high proportion of the leg injuries involved impacts with car doors and wings which, being flat and slightly deformable did not produce open or comminuted fractures. However the grid/bumper area and front wing corners tended to produce more severe lower injuries particularly if the initial impact of the motorcycle produced metal tearing with corresponding sharp edges. In many cases the injury was caused by a sole contact to a motorcycle or car component; trapping also occurred between the motorcycle and vehicle contacted. It was also observed that buckling of the motorcycle petrol tank occurred in a proportion of cases indicating that there may be potential for energy absorption by this component.

The assessment of collision speeds is always difficult in motorcycle accident studies and this particular study was no exception. The observations of witnesses and riders are often the only source as there is a damage threshold for accident-involved motorcycles beyond which impact damage is no longer an indicator. However the results indicate that over 60 per cent of the severe leg injuries were sustained at estimated collision speeds of under 40 miles/h (64 km/h).

The sites of injuries correlated with impact sites(Figures 1 and 2), with the AIS 1 injuries being evenly distributed between upper and lower leg regions. Injuries occurring above the knee have a higher level of severity than those below with over 75 per cent falling into the AIS 3 category. Some femoral fractures entail a long period in bed on traction (3 months or longer). This period of immobilisation can be shortened by major surgery but not all fractures are amenable to such treatment. There was a more even injury distribution in the lower legs, both between AIS 2 and 3 severity levels between left and right legs.

A high proportion of tibial/fibula injuries occurred at the AIS 2/3 levels and this often relates to the mechanism of injured referred to earlier, namely, trapping and crushing between uneven and jagged surfaces. Wound contamination is likely to occur with these particular injuries due to either torn clothing, paint, oil or any combinations of these contaminants. There is risk of infective and other complications of lower leg injuries,particularly with open or comminuted fractures, leading to extended treatment and prolonged recovery.

CONCLUSIONS

These preliminary findings have started to show trends concerning the vehicle components involved in leg impacts. Clinicial details have been confined to the severity and sites of injury. The following factors are indicated frcm the initial data:

Injuries resulting from collisions with cars (the majority situation) involved deformable panels (wings and doors) and less deformable structures such as wing corners, radiators, grills and bumpers. The latter were inclined to produce sharp edges giving rise to severe lacerations at the fracture site in most cases. The structures on the motorcycle principally causing injury are the handlebars in frontal impacts and the gearbox area for side impacts. It follows that any leg protection on the motorcycle must be of such a design to protect the leg from contact with these structures and also prevent crushing in the lower leg/ankle area. This body region appears to be particularly vulnerable. Some form of restraint system is required to prevent the rider going forward and striking his upper leg on the underside of the handlebars causing femoral fractures by the continuing forward movement of the trunk. A form of restraint may be necessary for the pillion passenger as added weight in a frontal collision may increase the severity of the driver's injuries.

The study is continuing with a more vigorous analysis when there is a larger data base. Clinical observations of surgical treatment, length of hospital stay and assessment of the degree of any physical disability will be presented in due course.

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