The Pathology of Violent Injury

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Preface

Injury and death due to trauma are inseparable from the modern way of life and, although crimes against the person are increasing, the greater proportion of the violence to which we are exposed is of industrial or accidental type. The emphasis of forensic pathology is, for this reason, turning increasingly from the study of criminality to the more widely based happenings of community medicine.

The Royal College of Pathologists has recently stressed the importance of trauma to our society. Its working party stated in 1972 that 'the amount of attention being paid to the pathology of injury is not commensurate with its size as a medical problem. It would seem that disproportionate amounts of money and time are being devoted to topics of far less urgency.'* Accidents, poisoning and violence, in fact, constitute the fifth largest grouping of causes of death in the United Kingdom.

Much of the work involved in the interpretation of violent death has fallen on the shoulders of full-time forensic pathologists whose number is too few to cope with the flow of cases. To overcome this, the Brodrick Committee recommended, as did the College, that hospital pathologists should become increasingly involved in work for the coroners—and, by implication, for procurators fiscal—and, whether the Brodrick recommendations are implemented as a whole or not, such a solution is already being imposed by circumstances.

The time therefore seemed ripe for a fresh look at forensic pathology, and that is what this book sets out to provide. It is intended not so much for the established expert in legal medicine as for those handling the treatment and pathology of trauma whose practice will inevitably contain an increasing proportion of medico-legal problems. Rather than follow the conventional format, the publishers have attempted to achieve their object by a series of reviews of contemporary themes which illustrate the many aspects of violence. The inclusion of a number of chapters which deal with more academic matters is intended to widen the interest of general pathologists and, perhaps, to encourage research in this field. The greater part of the book is, however, essentially practical and it is hoped that it will thus be of value to lawyers, coroners, fiscals and police officers concerned with injury and unnatural deaths.

* Hunt, A. C. (Ed.) (1972). 'Pathology of Injury', London: Harvey Miller & Medcalf Ltd.

The editor is grateful to the publishers for giving him this unusual opportunity to express his own views on the role of forensic pathology today. I must thank especially my personal secretarial assistant, Mrs. Gladys Hamilton, for facing a daunting project with unstinting co-operation and, as always, my wife who made no complaint over the many extra hours of work involved—we were, in fact, involved together in the final stages of preparation during her terminal illness. But the book is, of course, the collective work of the individual contributors and it is to them that major credit is due. I thank them all most sincerely for their forbearance and I hope that they will regard the completed whole as worthy of their efforts. Any opinions expressed in the text are, of course, personal to the author concerned.

Edinburgh 1977

JKM

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I

Injuries and death in motor vehicle accidents

Road traffic accidents are the most common cause of death in adults up to 50 years of age. The greatest number of deaths is in the age group 15–24 (Table 1.1) and the highest death rate occurs between 20 and 25 years.

Table 1.1 Fatal road traffic accidents, England and Wales 1973

Ages	*0–4*	*5–14*	*15–24*	*25–44*	*45–64*	*65–74*	*Over 75*	*Total*
Motor-cyclists	—	6	478	110	71	19	1	685
Other motor vehicles	52	73	1042	1000	775	258	148	3348

Figures abstracted from the Registrar-General's Statistical Review

The economic and social implications have stimulated research at both governmental and university level in many countries into the incidence and causes of road traffic accidents, the injuries sustained and how these may be alleviated or treated; in the United Kingdom, the work of Sevitt has been outstanding in this field.[17] Although the results may vary considerably, not only from country to country but also within different regions of one country, such research has produced many developments in road and vehicle safety; perhaps one of the greatest advances has been in the field of restraint systems such as the seat belt, the use of which is described in detail in Chapter 2.

The present purpose is to describe the fatal injuries sustained by unrestrained vehicle occupants and motor-cyclists in road traffic accidents and to discuss some of the causes. Those surviving will have injuries which are of similar distribution but of less severity, an aspect of applied pathology which is of major importance in designing treatment; death resulting from the late sequelae of injury is, however, outside the scope of this chapter.

The distribution and severity of the injuries sustained in an accident will depend upon:

1. where the casualty was seated;
2. the direction of the impact;

3. the design of the cabin;
4. the speed or force of impact;
5. the behaviour of the vehicle after impact—e.g. overturning;
6. ejection of the casualty;
7. the intervention of some other hazard—e.g. fire.

The use of motor vehicle space varies from country to country and between age groups within a country. In some areas, and particularly where young persons are involved, the vehicle often contains more persons that it was designed to carry. In the United Kingdom, by contrast, there is frequently either only a driver in the motor vehicle or a driver and a front-seat passenger; the driver was alone in 33 per cent of a series of fatal accidents studied personally.

Seating position

After pedestrians, the driver of the vehicle is the most frequent fatal casualty in road traffic accidents. This does not imply that he is exposed to more trauma; it merely reflects how often the driver is the only occupant of the vehicle.

Next in frequency is the front-seat passenger, followed far less frequently by rear-seat passengers. In the series here reported involving 100 fatal driver accidents, 74 passengers were also killed and, of these, 55 occupied the front seat.

Impact injuries

The impact is frontal in 80 per cent of fatal motor vehicle accidents and this applies whether there is a collision between two vehicles or whether it is a one-vehicle accident, i.e. the vehicle has struck a relatively solid or unyielding obstruction.

Although autopsy may show that the lethal injury is similar, the distribution of injuries will differ as between the driver and front-seat passenger owing to the different layout of the front of the cabin. Certain areas of the cabin may inflict specific injuries.[6]

It must not be forgotten that about 20 per cent of impacts are not frontal, and side or rear impacts produce their own special patterns of injury. The driver and front-seat passenger will be dealt with separately and according to the direction of force.

Unrestrained occupants of a vehicle which is suddenly halted will be thrown upwards and forwards until their progress is arrested by some part or parts of the vehicle or, if they are thrown out, by contact with the ground or some other object.

The mechanism of injury production is illustrated in Chapter 2. As the driver is thrown forward, his chest will come into contact with the steering-wheel and column. Unless the column is of the collapsing type, it will suddenly arrest the forward momentum of the body and

may inflict fatal injury to the internal thoracic structures. The head may be thrown into contact with the windscreen or with the upper windscreen surround and the roof. The legs, and especially the knees, may strike the fascia or dashboard.

Although the violence in many fatal impacts is such that any other factor has little relevance, the external injuries are influenced to some extent by the clothing, age and physical state of the deceased.

With regard to skeletal injuries, the only significant differences are those to the head and neck (Fig. 1.1). Forty-two per cent of car drivers

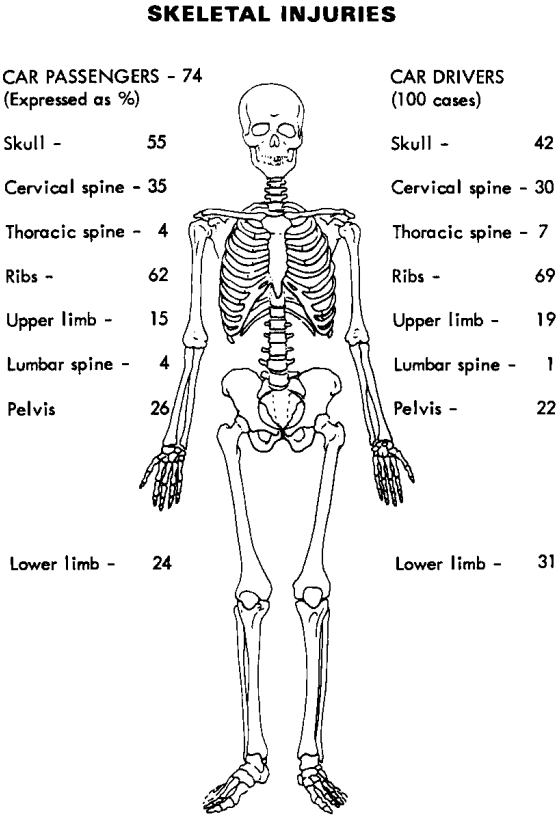


Fig. 1.1 A comparison of skeletal injuries sustained by drivers and passengers resulting from accidents involving 100 consecutive fatal driver casualties.

suffered fractured skulls as compared with 55 per cent of the passengers. Cervical spine injuries occurred in 30 per cent and 35 per cent respectively. Fractured ribs were 7 per cent more common among the drivers; otherwise, there were only minor variations.

The occurrence of major visceral injuries is shown in Fig. 1.2. As would be anticipated from the distribution of the skeletal injuries, the passengers showed a higher incidence of brain damage—64 per cent compared with 53 per cent in drivers. Injuries to the lungs, aorta and

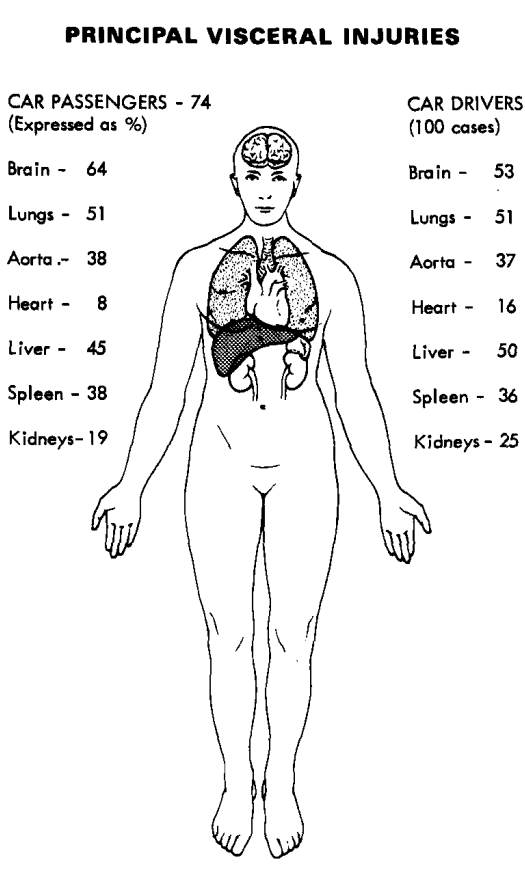


Fig. 1.2 A comparison of visceral injuries in drivers and passengers.

spleen were virtually identical but drivers sustained proportionately more injuries to the heart, liver and kidneys.

Some description and discussion of the distribution of the regional injuries is necessary for the proper understanding of these fatal injuries. Only the usual patterns of injury will be discussed, but it must be appreciated that, sometimes, these may be most bizarre.

Injuries to the head and neck

Serious injury to the head and neck is present in over 50 per cent of all fatal road accidents involving motor vehicle drivers or their passengers.

Glass injuries due to shattered windscreens are usually more widespread on the head and neck of the front-seat passenger (Fig. 1.3); they are rarely responsible for more than superficial damage but often cause injury to the eyes.

Skull fractures are conditioned by the form of impact. Drivers' movement may be restricted by the steering-wheel, which will prevent their ejection from the car upon impact and may materially lessen the force of any impact with the interior of the cabin or the windscreen.

Fig. 1.3 Typical windscreen injuries to the face of a front-seat passenger.

Passengers are not rarely ejected from the car, either through the windscreen or the door, sustaining severe fractures to the skull from impact with the roadway or some other object such as tree or wall. Fractures of the skull are sometimes depressed, especially following ejection from the vehicle, but most frequently they are basal, involving the middle fossae of the skull. Should the vehicle overturn, ring fractures of the base are not uncommon. Brain injuries are not remarkable, following the expected pattern and distribution of the skull fracture.

Cervical spinal injuries are common. The most important, and frequently the fatal, injury is a dislocation of the atlanto-occipital joint. This injury is found in about one-third of all fatal motor vehicle accidents and may easily be overlooked unless it is specifically sought. There may be no haemorrhage around the joint and, although extreme laxity with wide separation is occasionally seen, this dislocation is often only apparent on rotating or moving the skull in a horizontal plane. Rigor mortis may mask the injury and sometimes the ligaments are only torn or stretched on one side. Macroscopic injury to the medulla may be absent and the injured area may be incised during removal of the

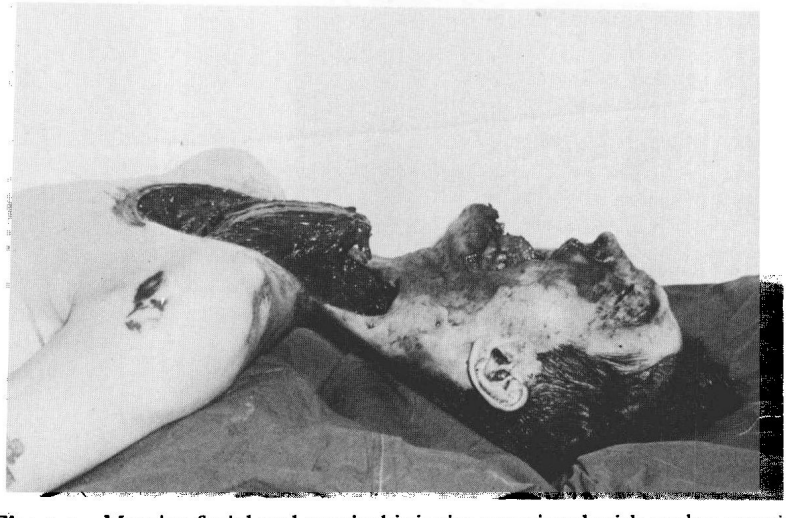


Fig. 1.4 Massive facial and cervical injuries associated with under-running a heavy goods vehicle.

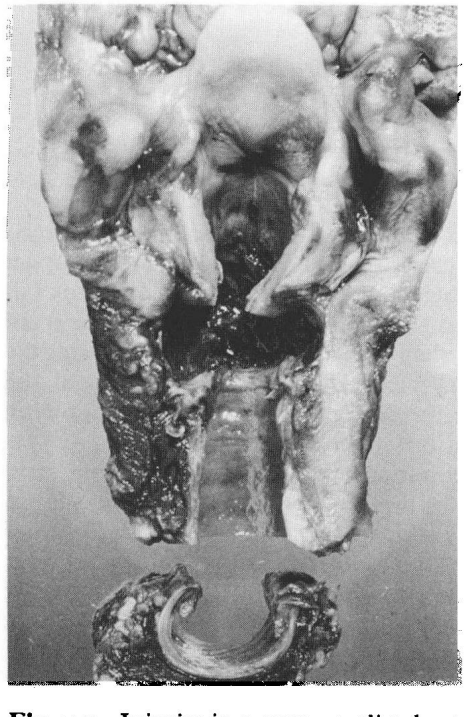


Fig. 1.5 Injuries in a motor-cyclist due to under-running the lowered tailboard of a stationary goods vehicle.

brain at autopsy. Dislocation of the cervical spine between vertebrae is less common and may, also, easily be overlooked. Frequently there is no macroscopic injury to the underlying cervical cord although the function of the cord has been virtually destroyed at the level of the dislocation.

One cervical spine injury, which is now becoming less common, is caused when a motor vehicle driver runs under the tail of a heavy goods vehicle and is virtually beheaded (Fig. 1.4). This injury is prevented by a transverse bar now being fitted below the tailboard. Severe and instantly fatal injuries to the soft tissues of the neck may occur when motor-cyclists or pedal-cyclists travelling at speed undershoot the tail-board of a lorry (Fig. 1.5).

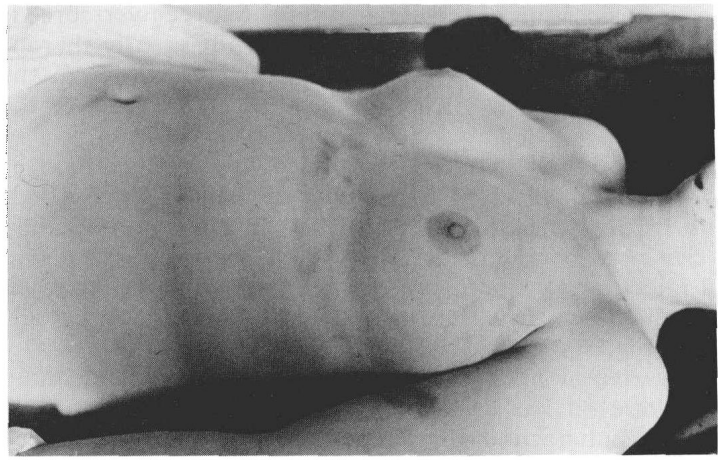
Injury to the vertebral artery, leading to rapidly fatal subarachnoid haemorrhage, is rare—it has been found in only 1 of over 200 fatal cases. Traumatic subarachnoid haemorrhage is becoming more frequently recognized following blows to the side of the upper neck[10]—a part of the body unlikely to be exposed to danger, except possibly from a side impact or when the vehicle rolls over.

Injuries to the chest

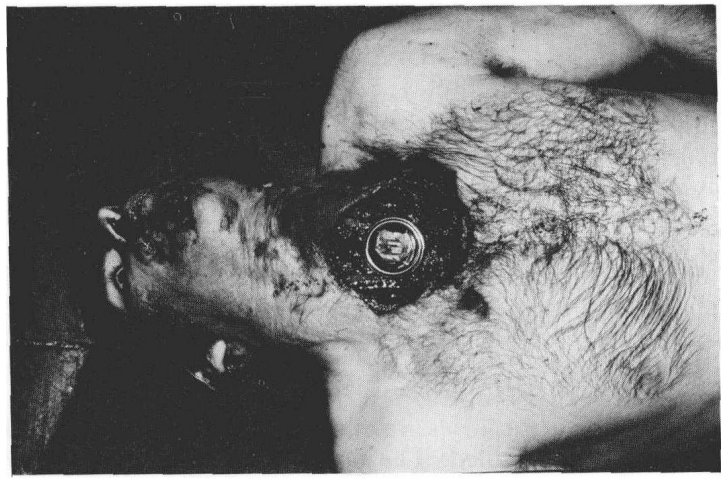
Chest injuries resulting from impact with the steering column or fascia occur frequently and are a very common cause of immediate death. The visible external injury to the chest from fatal steering-wheel impact may be minimal, or even absent, or it may be gross. In Fig. 1.6a, the imprint of the lower rim of the steering-wheel can be seen on the left chest and extending on to the arm whereas, in Fig. 1.6b, part of the column is actually in the chest. The appearances are greatly influenced by the clothing and by the age of the deceased. In young adults, the aorta or even heart may be extensively ruptured and yet the ribs and sternum are intact. Fractured ribs are slightly more frequent among car drivers than among their passengers.

It is of interest that severe injuries are often paired when a driver and his front-seat passenger are killed. The fatal and major injuries were similar in all but 1 of 11 such cases. This suggests that the design of the interior of the cabin has little influence on the injuries when the impact has been of great violence; by contrast, the interior design may be of great significance when the impact is slight.

In this series, the number of deaths from rupture of the aorta was virtually the same in the drivers and in the passengers. In the majority of cases, the lesion occurs where the transverse becomes the descending part but the aorta may occasionally rupture in the transverse or ascending section. The laceration may be complete—the severance is sometimes so clean that the ruptured ends appear to have been cut. In these cases death, or at least loss of consciousness, is immediate. All degrees of rupture may occur and sometimes the initial rupture may extend only to the adventitia or be very small. In both cases, the rising blood pressure after recovery from the initial shock may cause fatal haemorrhage which can be delayed for several days. More rarely,



(*a*)



(*b*)

Fig. 1.6 Two steering-wheel injuries. (*a*) Minor bruising of the skin of the chest. (*b*) A major injury in which the centre of the steering column has penetrated the upper chest.

mediastinal haematomas are due to injuries involving the intercostal arteries at their origins.

Injuries to the heart occur in some 16 per cent of car drivers involved in fatal accidents. The traumatic heart rupture is rarely the only fatal lesion; more usually it is merely one of many injuries incompatible with life. The right atrium is the part most frequently ruptured, followed by the right ventricle. Occasionally, the violence is such that all chambers are damaged and bizarre injuries may occur if a rib impales the heart. Figure 1.7 shows extensive injuries to the heart and the aorta.