THE RISK OF SKULL/BRAIN INJURIES IN MODERN CARS

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ABSTRACT

Skull/brain injuries to car occupants are still a major problem in road accidents, as they are a dominating cause of death, and for survivors, as they often lead to permanent problems. Many of the preventive actions in passive safety have therefore been directed towards injuries to the head.

In Sweden, it is since 1997 possible to link medical data coded according to ICD (International Classification of Diseases), and police reported accident data, for all cases where an injured person has been admitted to hospital. This provides an opportunity to study the influence of the car design on injuries.

In this study, a material from the police and the hospitals on the national basis has been used to study the influence of new car design. The method used was predominantly paired comparisons, which can control the influence of accident severity and other problems associated with exposure.

It was found, that there has been a dramatic reduction of skull/brain as well as facial injuries in the last years that can be related to the design of the cars. The reduction was in the order of 50-60% when comparing cars from 1984 with cars from 1995, involved in car to car impacts.

INTRODUCTION

Injuries to the skull and brain are the leading causes of death among car occupants involved in road traffic accidents (1). They are also the origin of severe and disabling injuries (1,2), and has therefore been of major concern for the protection of injuries to car occupants. Several preventive systems have been developed mainly to prevent from injuries to the skull and brain, as well as legislative actions.

There are mainly two injury criteria for brain injuries, measured in crash tests; peak acceleration and HIC (Head Injury Criterion). Dynamic impact tests have shown that there has been a positive development of the risk of receiving a skull/brain injury, based on HIC measured in frontal crash tests (3,4). The introduction of airbags is one measure that has proven to give positive effects.

The possibility to discover any positive impact on injuries in real life accidents is limited, due to the problem to collect large scale materials with enough depth of the medical data and technical data on vehicles. Nevertheless, positive effects can be seen if sound statistical methods can be applied to materials where medical diagnoses are available.

Several attempts have been made to study the impact of increased crash protection, also when single car models have been studied. Generally, it has been complicated to find a correlation, model by model, with crash test results, but on an aggregated level, such relationship has been found (5,6).

The objective of this paper was to study if there is a positive development on injuries to the head for newer car models compared to older cars, when exposure is kept under control.

MATERIAL AND METHOD

Two different materials were used; A and B.

A. To study the general development of fatal, serious and minor injuries to car drivers, police records from 1994 to 1997 were used, where the injuries were classified by the police.

B. To study the development of skull/brain injuries a database of injured persons admitted to all hospitals in Sweden during 1992-95, linked to police records, was used. ICD-codes on three-digit level were used to identify different kinds of injuries to the head. For the analysis of risks, only injuries to drivers in car to car impacts were used. In all 10 170 injured persons with known diagnose, were included in the study.

To obtain the risk figures on skull/brain and facial injuries for cars of different age, the paired comparison method was used, where the exposure base was all cars on the market colliding with the study population. A 3-year moving average was used.

The paired comparison method for car to car collisions (2) is a method where the accident severity is controlled for, and therefore, the risk figures are only sensitive, apart from the passive safety, to systematic differences in seat belt use and accident types, which does not seem to be likely to be sources of error.

RESULTS

Table 1 shows the number of injuries among car drivers admitted to hospital 1992-95. Skull fracture shows a consistent decreasing trend, where the proportion in relation to all injuries has been reduced by approximately 20% from 1992 to 1995.

Table 1.
The number of injured persons by main diagnose.

	1992	1993	1994	1995
Skull Fracture	109	108	90	83
Other head injury	897	868	809	841
Fracture, upper extr	168	138	166	151
Fracture, lower extr	272	224	214	222
Other injuries	1184	1093	1284	1249
Total	2630	2431	2563	2546

Figure 1 shows the relative risk of minor and fatal/serious injuries to drivers in cars from year model 1985 to 1997. While there has been only a small reduction of minor injuries, the risk of fatal and serious injuries have dropped by approximately 40% over the period, where the major reduction has taken place for cars of model year 1990 and later. To some degree this is associated with a vehicle weight increase during the period.

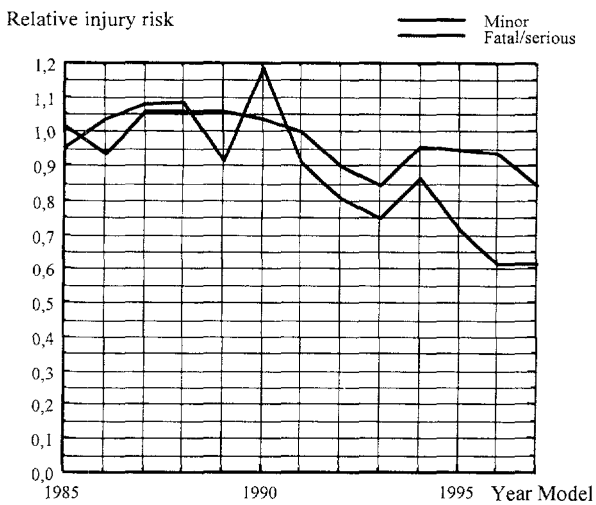

Figure 1. The relative risk of police reported minor and fatal/serious injuries to drivers of cars of different year models 1985-1997.

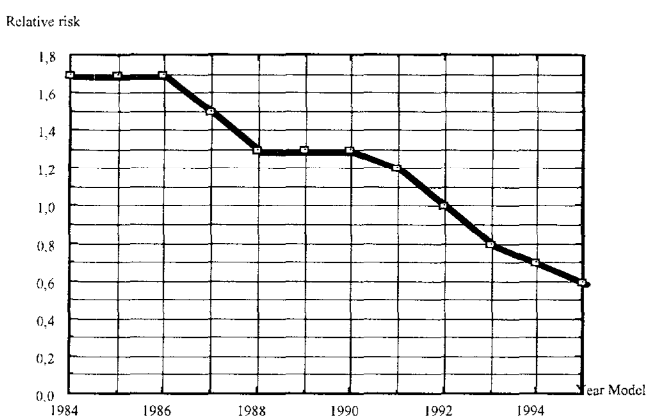

Figure 2. The relative risk of minor/moderate head injuries (ICD-coded) to drivers in car to car collisions with cars of different year model. n=1462.

The reduction of minor to moderate head injuries, mainly consisting of commotion, was 76% from year model 1984 to 1995. The major reduction occurred after 1990, where the relative risk fell by approximately 50%.

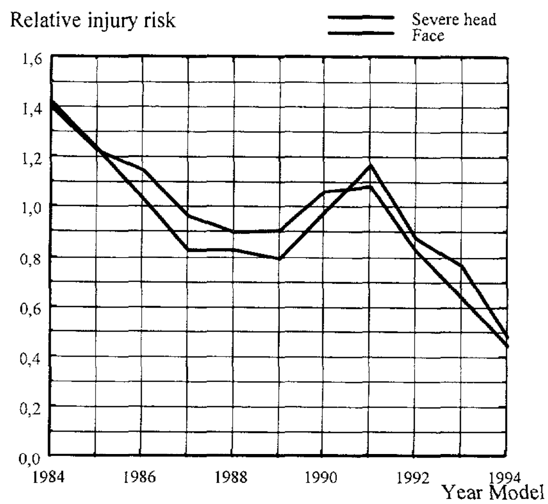

Figure 3. The relative risk of severe skull/brain injuries and facial in car to car collisions with cars of different year model. Facial injuries = 390, skull/brain injuries = 347.

Both severe skull/brain injuries as well as facial injuries have been reduced by approximately 60% from 1984 to 1994. There was an increase for both types of injuries in the late 80-s and early 90-s, but since 1991, there was a continuos decrease.

DISCUSSION

Skull/brain injuries is one of the major causes to the public health problem due to traffic accidents, being both the dominant causes of death, and often leading to permanent medical disability. It is therefore natural, that many efforts to reduce the harm caused by road accidents are directed towards injuries to the head (1).

It is of great importance that all these efforts that have been made during the last few years in terms of upgrading the safety performance of cars, are followed up. The investments made by the car industry and the consumers in safety are probably the largest ever, and it is therefore interesting to see whether this has lead to changes in real life accidents.

In crash tests, especially those made for the consumers, it is quite clear that the key values have undergone a positive trend. HIC values in full frontal as well as offset impacts are much lower for cars that have entered the market recently, and they can be tested at higher velocities than ever (3).

The possibilities to study the effectiveness of crash protection in real life accidents, are limited. Often, the safety impact of the design of the car is confounded by factors not associated to the car, but to the use of the car, the exposure and the accident severity. Such confounding factors can be controlled by using in-depth study technique. Such a technique is, however, hard to combine if a large number of accidents are to be used, and, furthermore, reconstruction of accidents might give a too low accuracy of accident severity variables (7). A matched pair technique offers the possibility to control several confounding factors. In this study, such a technique was used on a material with very good medical information, which is unique. The reliability as well as the validity of the data and results are therefore relevant. One factor that was not controlled for, was the use of seat belts. It is, however, not expected that the seat belt use could vary to such extent for cars of different year model, that it could alter the findings significantly.

One factor that might explain the somewhat surprising high effectiveness of safety development, is the fact that speeds and speed limits in Sweden are low, probably leading to that a smaller proportion of accidents are at a level, where the accident severity is higher than the segment where crash protection can act. This factor is also increased due to that only car to car collisions were included in the analysis. Accidents with trucks, lorries and buses, often leading to high accident severity would probably lead to somewhat other results. The increased weight of cars also can explain to a small part, the positive development.

The general positive development that can be seen during the 90-s, has also been seen in other studies taking place earlier. It is though important to realise, that there are major differences between individual car models. Probably, there are cars, that have a risk situation that is even better than shown by the present results. The reduction was not constant, and there were even signs of an increase in the early 90-s. This remains to be explained, but one fact is that several cars at that moment were prepared for, and also outside Sweden, equipped with driver side airbags.

The positive development as seen in crash tests would not be of any use if they did not address major part of those accidents where occupants would gain from crashworthiness development. It is, however, important to stress, that car safety, crashworthiness and occupant restraint protection, cannot solve accident outcome with very high severity, Those accidents must be addressed with other measures. If, on the other hand, such accidents are modified by infrastructure means, such as energy absorbing guard rails etc, the benefit from better crashworthiness could probably be larger than today.

The more or less constant risk of minor injuries can at first be considered as a small problem. It should, however, be stressed, that among these injuries, there is a large number of injuries to the neck, often causing long term consequences(2).

The positive development of head protection in cars, is a gradually increasing reason for the total decline in road deaths. It is, however, important to stress that the positive impact can only be fully used if seat belts are worn. The use of seat belts must therefore be 100% if all investments into passive safety should use its full potential.

Nevertheless, it is clear that the public health has gained significantly from the development of passive safety of cars. The total potential is, though, only used, if all cars in the population have the high safety level shown here. These results contrast to other findings, where the potential of increased crash protection has been estimated to be low(8).

The process behind the positive development seems to be the increased demand from consumers rather than newly introduced regulation. This process should be further stimulated, as there also seems to be a further potential in passive safety.

CONCLUSION

There was a high and consistent decrease of head and facial injuries in cars of model years in the 90-s compared to cars from the 80-s.

In car to car impacts, the reduction of injuries to the head, was in the order of 50-60%.

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