

Whiplash and prevention

Summary

A whiplash is caused by a sudden and violent movement of the head in relation to the torso. Whiplash injury is a combination of pain in the neck, pain in the head, and other health complaints. Annually, an estimated 30,000 to 50,000 people in the Netherlands incur whiplash due to a traffic crash, women more than men. Around 70,000 people suffer from whiplash complaints due to a road crash in the recent or less recent past. Whiplash complaints last longer for women than for men, and whiplash claims amount to 40% of the total costs of personal injury claims in the Netherlands. Whiplash is often caused by a rear-end collision in road traffic. Keeping sufficient distance and braking timely and quietly can help to avoid this type of crash. In case a rear-end collision does occur, the head rest needs to be adjusted at the right height (the top of the head rest must be on equal height with the top of the head), and the horizontal distance between head and head rest must be a maximum of 5 centimetres. Measurements show that correct adjustment leaves much to be desired; informing the public about this topic is recommended. Since 2009, tests focussing on head rests have been included in the EuroNCAP crash tests and these tests contribute to the total score; this is a positive development.

Background and content

Whiplash (injury) is a general term for a wide range of neck injury and other health complaints. They are mostly caused by a violent and sudden movement of the head in relation to the torso. This sudden movement happens mainly in vehicles that are crashed into from behind by another vehicle, as in a rear-end collision or a multiple collision, but it can also occur in other crash types.

In the hospital injury coding, whiplash is registered as non-serious, but several studies have shown that for some of the victims the health complaints can be both long-lasting and very disturbing.

Whiplash complaints are not just the result of traffic crashes, but can for instance also be the consequence of diving into water.

This fact sheet discusses the origin and consequences of whiplash as a result of rear-end collisions, and looks at the possibilities to prevent whiplash injury.

What is whiplash?

Whiplash injury or whiplash complaints are the names of health complaints that involve neck and head. The complaints develop after a sudden violent movement of the head as opposed to the torso. In rear-end collisions, these movements can happen even at low speeds of around 15 km/h.

Medically, it is a distortion of the neck vertebrae, but medical publications make clear that not only the vertebrae, but other tissue, even as far reaching as the brain, can also be injured.

The fact that whiplash injury cannot be detected by common means like an X-ray, and the fact that the complaints sometimes manifest themselves some time after the crash, can be a problem for making the proper diagnosis. In fact, whiplash is only diagnosed on the basis of a combination of several health complaints like pain in the neck, headache, sleeplessness, and concentration problems. The difficulty in diagnosing whiplash sometimes causes differences of opinion with insurance companies when casualties due to rear-end collisions file for compensation. It is not always easy to prove that a whiplash patient's complaints are indeed caused by that particular crash. In the 1990s, this was one of the reasons that various interest groups and organizations were started and for the arrival of lawyers specialized in whiplash injury. Since then, the police and other auxiliary services allow for the possibility of whiplash in rear-end crashes and provide the casualties involved with advice.

Although whiplash is generally considered to be a serious problem, whiplash organisations say that much information is still lacking. For example, the Whiplash Association Netherlands (WSN, 2000) stated that scientific research of the possible causes and effects of whiplash is urgently required. The Whiplash Centre Netherlands (WCN) is of the opinion that medics and lawyers often underestimate the problem. On the basis of a pilot study involving 79 Dutch whiplash victims, WCN (2002) recommends further research of, among other things, the prognostic value of various symptoms and

the effects of the head rests and the position of the back of the seat in combination with the victim's height.

How is whiplash caused?

Whiplash is mainly associated with rear-end collisions in road traffic. When a vehicle is hit from behind, the occupants will be suddenly forced backward, against the back of their seat. A head which moves freely can be moved backward in relation to the torso (hypertension) and then be bounced forward again (superextension).

The sudden backward movement results in a larger neck flexure than the forward movement, because in that case the chin hits the chest. That is why head rests are used to stop the backward movement.

What size is the whiplash problem in the Netherlands?

The best data on the extent of the whiplash problem in the Netherlands is that registered in OBiN (Injuries and Physical Activities in the Netherlands). OBiN is an annual internet and telephone survey among 11,000 Dutch citizens. Participants are asked if, in the past three months or longer ago, they sustained any kind of injury and if it still is a discomfort. The OBiN figures for 2006-2009 show that on any given moment in that period, 70,000 people experience discomfort from a whiplash that was incurred during a crash in the past. Per year, between 30,000 and 50,000 people incur whiplash complaints as the consequence of a traffic crash. In four out of five cases the victim drove a car. Two-thirds of all persons incurring a whiplash in any given year are male. This is very likely related to the fact that men drive more kilometres per year. Two thirds of all persons on any given moment who still experience discomfort from an earlier incurred whiplash are female, so the whiplash complaints last longer for women than for men. This is possibly related to the female neck structure, which is less strong than that of males (Van Kampen, 1996). It must be taken into account that OBiN's random sample for the category traffic is rather low, so that the margins are wide (source: Consumer Safety Institute; OBiN, 2006-2009).

On the basis of data from three insurance companies, TNO has found that almost a third of the total costs of personal injury claims in 1995 were due to whiplash complaints (Council for Road Safety, 1995). According to the 2008 figures of the international bureau PartnerRe, 40 percent of all costs of personal injury claims in the Netherlands are due to whiplash complaints, and for Europe this is 28 % (Van Ratingen et al, 2009).

How to limit the risk of whiplash?

There are two major categories of measures to prevent whiplash: primary and secondary road safety measures.

Primary measures are specifically meant to prevent rear-end collisions. The following measures can make a contribution:

- The *third brake light* on passenger vehicles and delivery vans. This extra brake light must give a more effective warning to following traffic when a car is braking. The idea behind this is that a triangular series of brake lights increases attention. Often, the third brake light of cars ahead can also be observed. The estimated effect of the third brake light is a reduction in the number of rear-end collisions of a few percent at the most (Schoon & Roszbach, 2000).
- The behavioural rule that tells the driver to keep distance from the preceding vehicle. Very short following distances are dangerous and annoying. Discouraging this behaviour frequently is the subject of a campaign; drivers who keep far too little distance on motorways can be fined. The principle is to keep at least a two seconds following distance. In metres this amounts to 56 metres at a 100 km/h speed, and 70 metres at 120 km/h. At free choice of speed, in light traffic conditions, this principle can easily be applied. In daily practice, with a heavy traffic volume, this is hardly the case, because a two seconds following distance leads to gaps that wide that overtaking traffic will fill the spaces (see SWOV fact sheet [Headway times and road safety](#)).
- Congestion detection and warning systems. Drivers are warned by variable message signs and a lower speed is imposed whenever this is necessary.
- Application of ACC (Advanced Cruise Control) in individual vehicles. This system not only fixes the speed at a desirable value, but also maintains the following distance, or headway time, at a pre-set value. When this value is reached, the system can automatically interfere by braking slightly. If this does not suffice, an acoustic warning signal follows. Such a system is less suitable for use in very busy traffic, when the traffic stream is not very steady (see SWOV fact sheet [Advanced Cruise Control \(ACC\)](#)).

The most important *secondary measure* is the head rest. This facility is nearly always present in a car, but it needs to be set at the right height to be effective, and the horizontal distance between head and head rest must be as small as possible (see below for the head rest requirements).

A periodic survey in the Netherlands indicated that approximately 50% of the passenger car front seat occupants have adjusted the head rest too low (DVS, 2008). The criterion in this survey was that the height of the top of the head rest is equal to that of the top of the head. All front seats are fitted with a head rest and 79% of the rear seats are equipped with a head rest. When head rests are present at the rear seats, they are ill-adjusted in 50% of the cases. The survey does not involve the horizontal distance between head and head rest. In 1995, the last measurements were carried out by SWOV, and they showed that in 28% of the cases the distance exceeded 10 cms; a distance that experts regard as rather large. The fact that the horizontal distance between head and head rest was too large was mainly caused by the back of the seat being in too tilted a position (Schoon, 1995).

The above indicates that especially the height adjustment of the head rest is very poor. The most recent Dutch campaign asking to pay attention to the correct adjustment already dates back to 1995.

As specific, whiplash related crash data (where and under which circumstances do whiplash crashes take place) is not available, we cannot comment on the effectiveness of the primary and secondary measures mentioned above.

What are the legal requirements for head rests?

By law, passenger cars are required to have head rests on the two outermost front seats; these are usually the left and the right front seat. In practice most cars are equipped with head rests on all five seats: two in the front and three in the back.

These head rests must meet specific European requirements. Besides their strength and the absorption, the minimal height of the head rests has also been determined. The height is of importance to support the head's centre of gravity at the right level, otherwise the head will turn over the head support. The European requirement for the permanent head rest is 80 cms between the top of the head rest and the seat (Van Kampen, 1993).

However, SWOV research shows that a minimum height of 85 instead of 80 cms is necessary to adequately protect 90% of the Dutch men (Van Kampen, 1996). Despite several efforts from the Vehicle Technology and Information Centre RDW, who represents the Netherlands in the relevant international meetings, they found no support for such an adaptation. The reason for this is that the inhabitants of other European countries generally are not as tall as the Dutch. Only hard and unambiguous evidence of the extent and the severity of whiplash complaints can convince 'Europe' of the usefulness of increased adjustment height.

The horizontal distance between head and head rest is also important for the prevention of whiplash. New European requirements are being developed, requiring a maximum distance of 4 to 5 centimetres given a normalised position of the back of the seat.

What are the current developments?

Crash safety requirements rear of vehicles

Several research institutes and car manufacturers are working on methods and criteria for the crash safety of the rear of vehicles. This would be a logical addition to the existing legal requirements for *frontal safety* and *side safety*. However, so far European agreement has not been reached on the manner in which a sufficient level of crash safety can be achieved. The construction requirements are intended to guarantee that the vehicle has a sufficient crumple zone, so that the occupants have the lowest possible deceleration in case of a rear-end crash if they are well secured in their seats. Considering the fact that whiplash can already occur at low crash speeds and low vehicle deceleration, such a lower deceleration is more likely to reduce serious injury of the neck, rather than to prevent whiplash.

Head rest innovations

Until now, several manufacturers have paid attention to protection in rear-end collisions by bringing out various technical solutions for the design of car seat and head rest. Such whiplash protection systems ensure that the head rest is placed directly against the head at the time of a crash; this prevents the head from tilting backwards before hitting the head rest. Reactive and proactive head rests can be distinguished. In reactive head rests it is the body weight which, in a rear-end collision, ensures a better head rest position; in pro-active head rests, a crash sensor in or behind the rear bumper activates the head rest.

Euro NCAP tests of chair-head rest combination

Since 2009, head rests have been incorporated in the Euro NCAP crash tests (see SWOV fact sheet [EuroNCAP, a safety instrument](#) and Euro NCAP, 2008). In these tests, dummies are used to test the car chair-head rest combination in three variants of crash severity at speeds of 16-24 km/h. The result of this test contributes to Euro NCAP's final test result. The crash tests are now still done according to best practice, as it is difficult to determine criteria for a good testing method. After all, the injury mechanism of whiplash is not yet fully understood. Although a scientifically sound evaluation has not yet been made, a few assessment studies show that chair-head rest combinations which in the evaluation are found to be good, are less often involved in physical injury claims than those which are found to be less good (Van Ratingen et al., 2009).

Conclusion

Annually, an estimated 30,000 to 50,000 people in the Netherlands sustain whiplash injury in a road crash. The total number of people with whiplash complaints as a result of a road crash in the recent or less recent past is 70,000. Whiplash complaints last longer for women than they do for men. In 2008, whiplash claims amounted to 40% of the total costs of personal injury claims in the Netherlands. In Europe, the average was 28 %.

Whiplash often is the result of rear-end collisions in road traffic. By keeping sufficient distance from the car in front and by braking timely and steadily, this type of crash can be prevented. In case a crash does happen, the risk of whiplash injury can be reduced by adjusting the head rest at the right height and by making sure that the horizontal distance between head and head rest is limited. However, studies show that approximately 50% of the front and rear seat occupants in passenger vehicles place the head rest too low. The assumption is that the horizontal distance between head and head rest often is also too wide (in 1995 in just over 30% of the cases).

The problems with the adjustment of the head rest can be remedied by whiplash protection systems that automatically position the head rest correctly at the moment of the crash.

A positive development is that well adjusted head rests now contribute to the total score of a Euro NCAP test.

Recommendations

Since the most recent information campaign in the Netherlands was held in 1995, it is advisable to ask attention for the proper adjustment of the head rest once more. Little is known about the circumstances surrounding severe whiplash injury and about the reason why whiplash complaints last longer for women. Further research on these issues, for example in a joint research together with insurance companies, is therefore recommended.

Publications and sources

(SWOV reports in Dutch have an English summary)

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