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## USE OF PROPERLY POSITIONED HEAD RESTRAINT

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**ABSTRACT**

A common injury among motor vehicle occupants involved in collisions is whiplash. The whiplash injuries primarily result from abnormal loading placed on the cervical spine during automotive rear impacts. This type of injury is a common cause of chronic neck pain in industrialized countries. Properly positioned head restraints decrease the incidence of whiplash. Optimal head restraint must be located above the ears (vertical height) and touching the back of the head (horizontal gap). In this study it is found that use of optimal head restraint which is correctly positioned behind and close to the head is only 7.16%. It is clear that public education programs will be effective in increasing the proper use of the head restraint to decrease the whiplash injuries.

**KEYWORDS**

Head restraint; Injury; Neck pain; Safety system; Whiplash.

**1. INTRODUCTION**

In rear-end collisions, an occupant's unsupported head lags behind as the torso is accelerated forward (Von Koch et al., 1995). This phenomenon of sudden acceleration-deceleration motion, was first documented in 1928 and given the term 'whiplash' (Galasko et al., 1993). Whiplash injuries of the neck which result from acceleration-deceleration forces applied to the neck, usually in motor vehicle collisions are one of the most common injuries reported from vehicle rear impacts (Cassidy et al., 2000). This type of injuries which are widespread cause of chronic neck pain have become increasingly common in motorized countries throughout the world (Zuby et al., 1999; Viano & Olsen, 2001; Farmer et al., 2003) Symptoms of whiplash include pain in the neck, shoulder, or arm; headache; jaw pain; dizziness; tinnitus; and memory and concentration difficulties (Spitzer et al., 1995; Cassidy et al., 2000). It is well known in clinical literature that whiplash injuries affect cervical soft tissues, and increasing spinal motions are likely responsible for greater injury risk (Bogduk, 2000; Cusick et al., 2001; Stember et al., 2005b).

Several different parameters have been found to affect the injury risk in a rear-end impact. Gender, stature, age, seating position, and sitting posture are factors found to influence the risk of injury (Krafft et al., 1996; Morris & Thomas, 1996; Otte et al., 1997; Krafft, 1998; Temming & Zobel, 1998; Langwieder et al., 1999; Jakobsson & Norin, 2002). Several studies indicate that front-seat occupants have a higher whiplash injury risk than rear-seat occupants (Lundell et al., 1998; Jakobsson & Norin, 2002).

Head restraint devices are designed to minimize or prevent injuries in rear-end collisions (Von Koch et al., 1995). Evidence comes from insurance data shows that restraints decrease the incidence of whiplash (IIHS, 1999;2002; Young et al., 2005). However, to prevent whiplash injuries head restraints must be properly positioned (Young et al., 2005). Vertical and horizontal positions of the head restraint has been shown to be important in reducing the whiplash injury. Head restraint which is not behind and close to the back of an occupant's head has not effective to prevent a 'whiplash' injury in a rear-end collision. Increasing head restraint height decreases injury risk (DeRosia et al., 2004). A relationship was found between head restraint height and whiplash, with nearly a two fold increase (35% vs 66%) in rear crashes with low head restraint positions (Viano & Olsen, 2001).

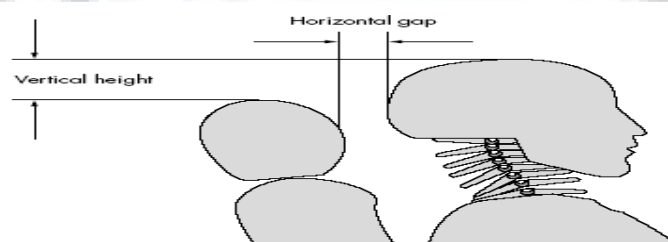
Head restraint which firstly introduced in the 1960s was designed to limit relative motion between the head and thorax or reduce the effect of whiplash by minimizing the neck movement and reducing spinal motions that occurs in motor vehicle accidents (Von Koch et al., 1995; Young et al., 2005). Several studies have assessed the effectiveness of head restraints in rear-end crashes. The estimated effectiveness of head restraints in reducing the risk of neck injury ranges from approximately 5% to 30% (Szabo et al., 2003). Head restraints decreased the overall risk of neck injury. Governmental research reported that head restraints reduced the overall neck injury risk by 5–20% (Stember et al, 2005a). The research by Viano and Gargan (1996) about head restraint position during normal driving indicate that if all adjustable head restraints were adjusted to the proper vertical height, a 28.3% reduction in whiplash injuries occurring in rear-end collisions would result (Fockler et al., 1998). Use of head restraints with the correct vertical height should significantly reduce the incidence of soft tissue injuries (Fockler et al., 1998).

The purpose of this observational study was to assess head restraint positioning in sample of Turkey.

**2. METHODS**

Head restraints are evaluated based on two criteria. The first is the distance down from the top of the head of an average sized male to the top of the restraint (IIHS, 1999; Young et al., 2005). A head restraint should be at least as high as the head's center of gravity, or approximately 3.5 inches (9 cm) below the top of the occupant's head (IIHS, 1999; Young et al., 2005). The second criterion is the horizontal distance from the back of an average sized male's head to the front of the restraint. A horizontal distance of more than 4 inches (10 cm) has been associated with increased symptoms of neck injury in motor vehicle accidents (IIHS, 1999; IIHS, 2003; Young et al., 2005).

To assess head restraint positioning, the vertical height of the head restraint and the horizontal gap between the head and the head restraint were assessed (fig 1). Reliably assessing a good horizontal dimension (that is, back of the head less than 4 inches) in a moving vehicle is difficult. For ease of data collection, therefore, the criteria was modified for a good head restraint position by defining optimal horizontal position as when the back of the head is touching the head restraint. In this paper, it is used the term "optimal" head restraint positioning to indicate a head restraint level with the ears and touching the back of the head.

**FIGURE 1: HEAD RESTRAINT POSITION**

Adjustable head restraints were defined as correctly adjusted if the top of the head restraint was approximately level with the top of the driver's ears or higher. Therefore, all head restraints observed to be positioned so that the top was lower than the driver's ears were defined as incorrectly adjusted. Data for his study were collected in July, September and October 2012. This study was performed in Ankara which represents high level contribution GNP cities of Turkey and high level of average income and high level of education. 1425 vehicle drivers were observed that they are using appropriate head restraint or not.

### 3. RESULTS AND DISCUSSION

To prevent whiplash injuries, car head restraints must be correctly positioned behind and close to the head. Currently, only 7.16% of drivers meet these standards in this study.

TABLE 1: USE OF HEAD RESTRAINT

	Correct horizontal gap and vertical height (restraint level with the ears and touching the back of the head)	Only correct horizontal gap (vertical height is incorrect)	Only correct vertical height (horizontal gap is incorrect)	Incorrect horizontal gap and vertical height
n (total 1425)	102	23	456	844
%	7.16%	1.6%	32%	59.2%

In this study it is found that 1.6% of drivers use only optimal horizontal distance and 32% of them use only optimal vertical height. Jeroshch et al. defined "optimal" horizontal distance between the back of the head and head restraint as being 0 cm and found that only 7.4% of drivers use optimal head restraint distance (Jerosch et al., 1997; Young et al., 2005).

To prevent whiplash injuries, car head restraints should be correctly placed very close to the back of the head. Viano et al showed that the proper position of neck was with a head restraint positioned above the ear (vertical) and less than 2 inches from the back of the head (horizontal) (Viano and Gargan, 1996; Young et al., 2005). In a study it is found that only a small proportion of drivers meet these standards in Portland, Oregon (Young et al., 2005). Despite including all types of vehicles, it is calculated that only 10% of drivers had head restraints in the most appropriate position (Viano and Gargan, 1996; Young et al., 2005). A lack of public awareness about effectiveness of properly positioned head restraint to prevent whiplash is probably reason for this result. (Young et al., 2005)

Head restraints which the most effective device to prevent injury at smaller backset magnitudes (<60 mm) by limiting spinal motions under whiplash conditions (Stember et al., 2005b) are usually not positioned correctly to limit head-neck motions within the physiologic range (Minton et al., 2000; Farmer et al., 2003, Stember et al., 2005b). Effectiveness of head restraints increases as they are positioned higher (Hell et al., 1998; Chapline et al., 2000; Farmer et al., 1999; Kleinberger et al., 1999; Tencer et al., 2001; Welcher & Szabo, 1999; Szabo et al., 2003.) and closer (Szabo & Welcher, 1996; Farmer et al., 1999; Watanabe et al., 1999; Welcher & Szabo, 1999; Chapline et al., 2000; Szabo et al., 2003) to drivers' heads.

### 4. CONCLUSIONS

It could be concluded from the results of this study that head restraints have to be improved. Two major obstacles for the appropriate use of the head restraint are lack of public awareness and improper design of the headrest. It is clear that public education programs will be effective in its use of the correct head restraint in decreasing the incidence of whiplash injuries.

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