

THE FORENSIC SCIENCES

G A Z E T T E

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EDITORIAL COMMENT:

MORE GAZETTES TO COME

For those faithful readers who have not "turned blue" since the New Series Volume III Number 2 styled May, 1986, and produced much closer to January, 1987, comes another effort: Number 3, fancifully styled August 1986 but actually printed in January, 1989. Januarys in these odd-years have been good months for the *Gazeteer*.

Everyone coming to realize the sporadic history of the New Series is encouraged both to practice patience and to send in articles written during the intervals between issues.

The current, just-ended hiatus is similar to all the others—the press of work compared to the number of workers. More cases are being reported, more are being autopsied, more cases are going to trial, and there are fewer staff members to do the work here at *SWIFS*.

An additional factor, unrelated to workload, is the crash of the hard drive on which most of the format of the *Gazette* had resided. Alas, with inadequate *backup*. For want of the *backup*, the shoe was lost, for want of the shoe the horse was lost, for want of the horse the...battle was lost, and all for the want of a nail (the *backup*).

As there may be a few gentle readers unfamiliar with computers and word processors, a *backup* is a copy of information stored in another place or another form in case of electronic derangement, power failure, or other catastrophic event generally termed a *crash*. *Crashes* follow Murphy's Law: If anything can go wrong it will go wrong, and at the worst time.

...see EDITORIAL continued inside

ALSO IN THIS ISSUE

- * A Review of Seat-Belt Related Items in the December *JAMA*
- * High Velocity Versus Low Velocity Airplane Crashes

A COMMON MISUSE OF SEAT-BELTS

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ABSTRACT

Seat-belts are generally accepted as reducing both levels of injuries and numbers of fatalities when used in the recommended fashion. However, there is one type of seat-belt, namely the three point seat-belt with the *window shade* slack feature, which is extremely easy to misuse. As a result, users of this type of seat-belt are not always afforded the protection they expect in a crash situation. The characteristics of this type of seat-belt will be explored, and autopsy findings from a case involving the use of the *window shade* seat-belt will be detailed.

INTRODUCTION

The presence of seat-belts in motor vehicles is mandated by Federal Motor Vehicle Safety Standard (FMVSS) 209.(1) However, the presence of such a restraining mechanism offers only the potential for injury reduction; it is up to the individual user to make use of the combined lap and shoulder belts so as to allow for injury reduction in a motor vehicle crash. When seat-belts are used, there is general agreement in the scientific community that they are effective in reducing injury levels. In some rare cases, however, it has been shown seat-belts can actually exacerbate the injury level.(2)

...see MISUSE continued

MISUSE...

Occasionally, the pathologist will have occasion to examine a person who was killed in an automobile crash, and who was wearing a three point restraint system (combined lap belt and shoulder belt). One possible contributing factor in such deaths is the presence of the *window shade* mechanism which induces slack in the shoulder harness. (A *window shade* seat belt is one in which the level of slack can be adjusted by pulling on the shoulder belt. The slack is set in the same manner as one sets a window shade, and thus the name *window shade*.) In such death cases, the occupant is belted in, but due to the induced slack, the upper torso of the occupant is relatively unrestrained in a crash, thereby allowing for the increased injuries.

SEAT BELT DESIGN

As a rule, three point seat belt systems present in passenger vehicles in the United States make use of the *Emergency Locking Retractor*. This type of seat belt allows the upper torso to move freely until the vehicle accelerates or decelerates rapidly. Under normal conditions, the shoulder belt is unrestrained and allows movement within the vehicle. During pre-crash and crash conditions, however, a small pendulum swings and positions a locking bar into the ratcheting teeth of the seat belt retractor reel. This prevents the reel from extending the length of the shoulder harness during such a crash.

There are two major variations of the emergency locking retractor seat belt system presently in use in the United States. The domestic car manufacturers (Chrysler, Ford, and General Motors) make use of a shoulder restraint system that includes the *window shade* feature. The foreign car manufacturers, including those from England, Japan, West Germany, and Sweden, do not include such a *window shade* feature. Foreign manufactured cars which are imported by domestic manufacturers, such as the Dodge Colt and Chevrolet Sprint, are also not equipped with the *window shade* mechanism.

Just as one sets the height of a window shade, one can pull on the shoulder belt and cause extra length (slack) to be introduced into the seat belt system. When one releases the shoulder belt, the amount of slack stays constant. In use, it is possible to introduce between about 12mm (1/2") and 356mm (14") of slack in the shoulder restraint, either inadvertently or intentionally. Owners manuals typically recommend that no more than 25mm (1") of slack be introduced into the shoulder harness, so that the efficiency of the seat belt

will not be reduced in crash situations.(3) It should also be pointed out that many car owners do not take time to read these manuals.

The rationale behind the use of the *window shade* feature is that persons will be more apt to wear seat belts if they are not as tight during normal use. However, a recent study has shown that drivers in foreign cars were more apt to wear shoulder belts than were drivers of domestic vehicles.(4) In addition, the same study found that domestic car drivers were much more apt to have slack in the shoulder belt than were drivers of foreign vehicles.

TESTING OF SEAT BELT TYPES

Tests were made in an American-made car which had in it the *window shade* type shoulder belt. With a 102mm (4") length of slack, one author's head hit the very top front of the windshield at the point where it is joined to the sloping roof during 0.7 g deceleration from a 32 kmph (20 MPH) speed. This exercise was carried out several times from differing speeds ranging from 24 to 40 kmph (15 to 25 MPH), with similar results. The deceleration level was determined by the amount of brakes-locked friction available between the tire surface and a Portland cement pavement. Calculations based on skid mark length yielded the average deceleration level of 0.7g.

The same series of tests was repeated in the same vehicle, but with the *window shade* feature disabled. (The *window shade* feature is disabled whenever the car door nearest the shoulder belt is opened) With this feature disabled, there was never any slack in the belts. Test results showed that the author's head was stopped at varying distances of 3" to 5" from the intersection of the windshield and the descending roof.

Tests conducted by the National Highway and Traffic Safety Administration quantify the exact relationship between shoulder belt slack and injury level.(5) Using a standard shoulder harness with the *window shade* feature, tests were run of four anthropomorphic dummies; slack levels of 0, 25, 50, and 425mm (0, 1, 2, and 16.75 inches) were induced. HIC (Head Injury Criterion) values for 48 kmph (30 MPH) crashes were 439, 641, 796, and 1802 for the four levels of slack, respectively. A greater HIC value corresponds to a greater level of head injury.

Additional tests were conducted by the authors on both foreign and domestic cars to see what extra amount of slack was introduced into the shoulder belt during crash decelerations prior to

the time that the emergency locking retractor could restrain further advances in shoulder belt length. At the .7 g deceleration level, 12mm (1/2") was the typical amount of extra belt length induced before the shoulder belt locked. At lower deceleration levels, up to 25mm (1") would be induced. However, no amount greater than 25mm (1") extra length was ever allowed by the emergency locking retractors. This is very much in keeping with the requirements of FMVSS 209.

FINDINGS & CORRELATIONS

The injuries present on an automobile crash victim that are caused by seat belt usage are well known. Typically, they include abrasions and contusions across the pelvic region and across the upper torso from the shoulder to the pelvis area. If the seat belt is worn properly, these injuries should be relatively insignificant.

However, the pathologist will occasionally be called upon to examine a body which bears the typical seat belt markings and on which there is extensive (and fatal) head trauma. In the pelvic region, there are contusions and abrasions which are both consistent with lap belt trauma. On the front of the left shoulder there was a focal contusion on the muscle beneath the subcutaneous fat. This was consistent with shoulder harness trauma. The police report confirms that the deceased was wearing a combined lap and shoulder belt at the time of the fatal motor vehicle accident.

Examination of the body revealed that the skull of the deceased contained a fracture running through the front part of the floor of the left middle cranial fossa and ending near the rear portion of the left cribriform plate. Associated with this fracture were fracture contusions of the lower left temporal lobe and a subarachnoid hemorrhage at the base of the brain. Also, hemorrhage of the neck musculature was present. Further hemorrhaging was found at the site where the vertebral artery lies adjacent to the foramen magnum. The cause of death for this individual was determined to be injuries to the head, neck, and brain.

This individual was wearing a *window shade* type seat belt at the time of his death, and was the driver of a mini-van of domestic manufacture. During the crash, the vehicle rolled over several times. Based upon the fracture of the skull, it would be reasonable to conclude that the actual mechanism which induced this fracture was the crushing of the head between the vehicle and the ground as the vehicle rolled over. It has been our

experience that rollover accidents quite commonly induce skull fractures and related head injuries whenever the head leaves the passenger compartment and is crushed by the weight of the tumbling vehicle.

Examination of the vehicle revealed that the roof frame, door frame, and the A-pillar of the van did not undergo serious plastic deformation during the crash. Thus, the passenger compartment near the driver's head was dimensionally the same prior to and during the crash, and a change in the vehicle's structure did not allow the driver's head to be suddenly exposed to the potential for trauma outside the shell of the vehicle. Although the amount of slack present in the seat belt system at the time of the crash is unknown, seat belt slack was suspected as one possible explanation as to why a seat belted victim's head could escape the passenger compartment and be crushed between the door frame and the ground. Tests made with a similar type vehicle showed that a 102 mm (4") level of slack would allow for the head to easily escape the passenger compartment via the driver's window area if the window were down or were broken. Further testing showed that it would have been very difficult for the head to be outside the passenger compartment in a position to be crushed if the seat belt had been worn properly (that is, without slack). It should also be noted that the left lower arm had abrasions which appear to be *road rash*; *road rash* of course occurs when the skin is abraded by the road, and this also implies that the body was partially out of the vehicle during the tumbling.

The presence of the subarachnoid hemorrhage is also consistent with injuries that occur when the head is relatively unrestrained. Typically, this type of injury is brought about by blows to the face or neck. The literature has reported several instances in which basal subarachnoid hemorrhage was found in motor vehicle accident victims.(6)(7) In this particular instance, the hemorrhage would have been a result of the head and neck flailing in the vehicle while the vehicle was tumbling. During the rolling of the vehicle, the head struck part of the vehicle's interior, causing the trauma.

DISCUSSION

Seat belt slack can certainly be a factor in head injuries, as demonstrated by the NHTSA tests and the authors's own experiences. Unfortunately, seat belt slack is a form of misuse of the seat belt; as such, it does not provide the user with the protection that he/she expects. One very common way in which seat belt slack is induced is by adjustment of the seat. The passenger can be wearing a taut seat belt, but decides to have more leg room; he

thus scoots his seat towards the rear of the vehicle. The *window shade* feature prevents the seat belt from retracting when the seat is moved back, and this results in several inches of unintended slack.

Fortunately, FMVSS 208(8), which requires passive restraint systems, is now being adhered to by many car manufacturers. As a result, many new cars are now being sold with automatic safety belts. Such belts do not have the *window shade* feature. Also, the large number of imported cars in this country causes the number of cars with *window shade* mechanisms to be on the decline.

SUMMARY

It is unfortunate that the *window shade* mechanism is present in some motor vehicles. The merits for its inclusion are greatly outweighed by the increased potential for head injuries. It is also sad to think that many individuals who consciously wear seat belts for increased safety can be denied this safety because of a feature in seat belts that makes them extremely easy to misuse.

The forensic pathologist who is examining a body that shows non-fatal seat belt contusions and abrasions and fatal head injuries would be well-advised to consider the *window shade* mechanism as a contributing factor in the death. A seat belt that has too much slack in it would indeed be one possible explanation as to why a belted driver or passenger sustained fatal head trauma.

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THE CHIEF GAZETTEER NOTES:

The 1986 DOT report (DOT HS 807 018) and Greenberg (1987, reference 2) in the Goodson and Besant-Matthews article indicates that seat-belts can cause injury. Some have used these sources to conclude that seat-belts should not be worn.

The Chief Gazetteer regards this as a serious misinterpretation. Injuries attributable to belts (when properly used) are much less severe than injuries of the unrestrained occupant. More recognition is needed of *misuse of seat-belts* leading to injury.

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EDITORIAL (Continued from front)

The *Gazette's* format has been regenerated, another worker has joined the ranks, and the *Gazette* is, perhaps, "on a roll". Patience, as other virtues, is its own reward. Thank you for yours.

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