CASE REPORT

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Transection of Trachea Due to Improper Application of Automatic Seat Belt (Submarine Effect)

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ABSTRACT: The seat belt has been a major contributor in minimizing injuries in automobile accidents. However, it often causes characteristic patterned injuries to the body relative to its application at the time of an accident. We report an unusual case of a driver who sustained a transection of the trachea due to the "submarine effect" from improper application of the seat belt.

KEYWORDS: pathology and biology, trachea transection, seat belts, submarine effect

The seat belt is well known to reduce and prevent serious injuries in automobile accidents [*1*]. Seat belts were introduced in the 1950s and became widely used and finally required by law in the 1960s [*12*]. Injuries attributed to seat belts have been documented as early as 1956 [*2*]. Their use is highly advised and post legislation studies have demonstrated an overall decrease in the severity of injuries sustained automobile accidents when seat belts are used. The use of the seat belt has resulted in marked reduction in mortality and morbidity in motor vehicular accidents. Fatal and severe injuries are reduced at least 35% through the use of the seat belt. Lesser injuries are reduced 50 to 70% [*12*]. However, the seat belt use has been associated with various abdominal, vertebral and vascular injuries (seat belt syndrome) [*7,13*].

Certain restraint systems, such as the shoulder/lap belt used in conjunction with an airbag, offer optimal protection. Federal safety regulations require an airbag or seat belt for the front seat occupants of automobiles. Since 1984 automatic motorized seat belts have been in use, especially in small passenger cars, as an alternative means to airbags to meet federal requirements [*3*].

Automatic seat belts move into place around the front seat occupant when the car door is closed. While some automatic seat belts combine lap and shoulder restraints, others use an automatic shoulder belt with a manual lap belt that must be fastened separately by the occupant [*4*] (Fig. 1).

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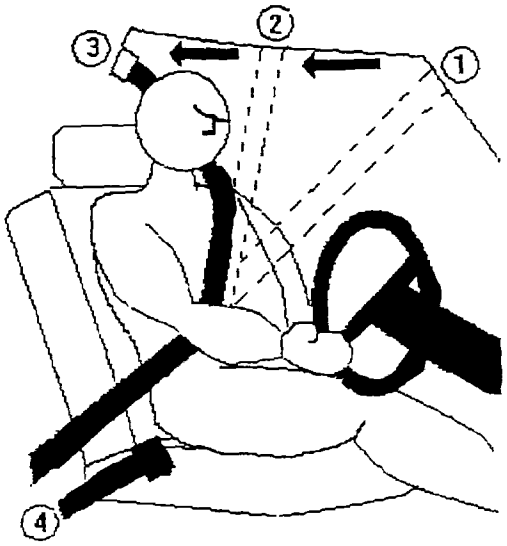

FIG. 1—*The automatic shoulder belt starts at position (1) and travels along a track in the door frame (2) into place at position (3). The lap belt must be fastened manually (4).*

Failure to manually buckle the lap belt can result in the "submarining effect," which can cause devastating trauma to the occupant (Fig. 2) as we had the opportunity to observe at the Medical Examiner's Office, Westchester County, New York.

Case Report

A 29-year-old obese female was on her way to work through an interstate highway (I-95) in Westchester County, N.Y. on January 9, 1992. She was observed driving her

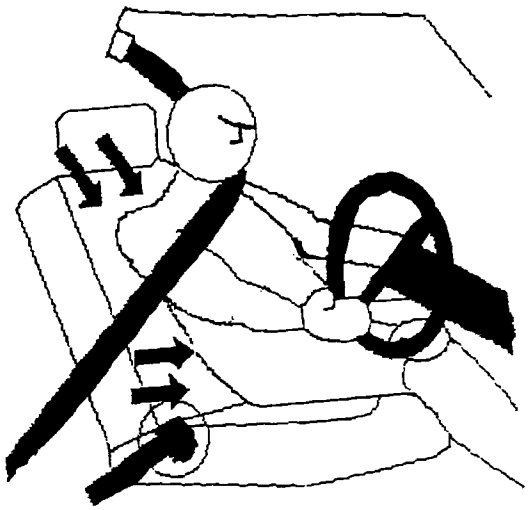

FIG. 2—*With the manual lap belt unfastened (see circle) the occupant runs the risk of "submarining."*

imported compact car at a high rate of speed in a passing lane. The road condition was slippery and icy due to the extreme weather conditions comprised of snow, sleet, and freezing rain. Witnesses observed her car striking the guardrail on the median; it then crossed three lanes and struck the overpass structure. The vehicle was equipped with an automatic seat belt. She was found dead in the driver's seat with only the shoulder belt applied. The lap belt was found unfastened. The steering wheel was bent. The front of the car was severely damaged (Fig. 3). The body was removed from the scene to the Medical Examiner's Office for an autopsy.

The autopsy revealed a moderately well developed and obese female measuring 170.18 cm (67 inches) weighing 95 kg (210 pounds), appearing to be the stated age of 29. The face, neck, and chest revealed diffuse swelling of the soft tissues with crepitation on palpation (subcutaneous emphysema). There was an oblique dark reddish/brown band-like abrasion extending from the left lateral aspect of the neck to the right upper anterior aspect of the chest measuring 26 cm in length with a width of 1.5 cm. (Fig. 4). The neck showed diffuse dark reddish hemorrhage in the subcutaneous tissue. There was a complete transection of the trachea beneath the cricoid cartilage. (Fig. 5). The mucosa of the larynx was separated from the surrounding cricoid and thyroid cartilages with hemorrhage. (Fig. 6). The carotid arteries and jugular veins were intact. The liver weighed 1410 grams. The capsule revealed multiple irregular lacerations on the anterior and posterior aspect of the right lobe measuring 3-5 cm in length. (steering wheel impact injuries).

The heart weighed 320 g. It showed no evidence of trauma. The right lung weighed 250 g, and the left 230 g. There was no evidence of trauma to the lungs. The spleen, adrenal glands, and kidney were unremarkable. The brain weighed 1260 g. There was no evidence of injury to the skull and brain.

Discussion

The "seat belt syndrome" was first coined by Gannett and Braunstein in 1962 [7]. The injuries are classified into three categories according to the application of the seat belt: injuries due to shoulder belt, injuries due to lap belt, and injuries due to combined shoulder-lap belts (three point belts).

Skold et al. reported several cases of cervical spine injuries due to seat belt use, specifically attributed to "submarining" in which the occupant's body slips forward with

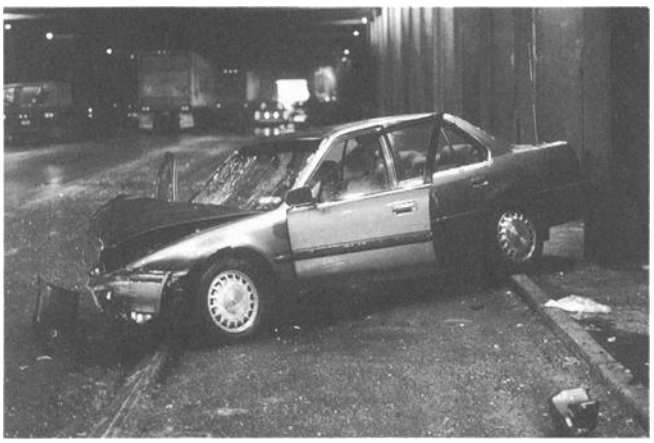

FIG. 3—*An imported compact car with severe front end damage following impact with wall.*

FIG. 4—*Seat belt injury to the neck and right anterior chest wall. The swelling of the face, neck and chest wall is due to subcutaneous emphysema.*

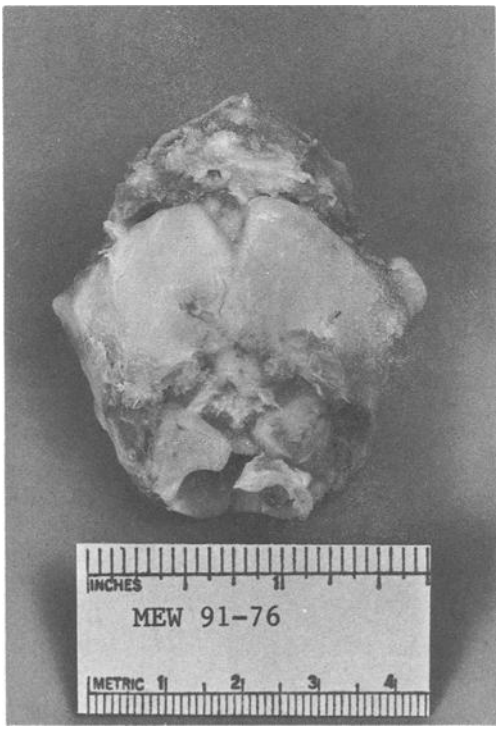

FIG. 5—*Frontal view of transected upper trachea below cricoid cartilage.*

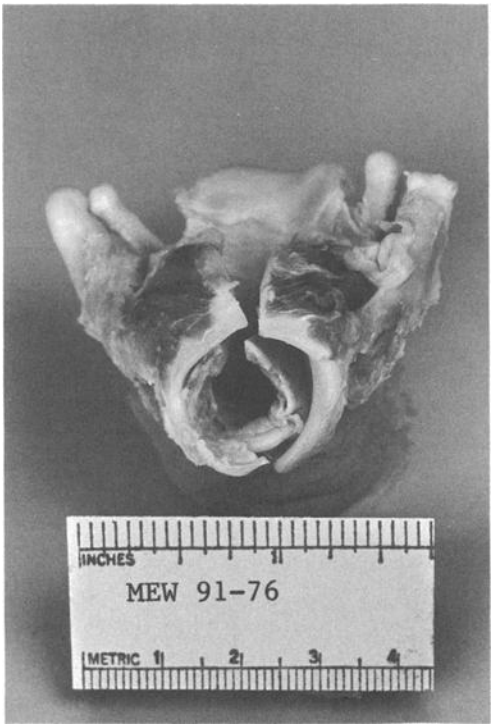

FIG. 6—*Inferior view of transected trachea. Separation of mucosa and submucosa from cartilage is apparent.*

the head and neck being held by the shoulder belt [*11*] (Fig. 2). We found eight cases of carotid trauma reported in the literature, five of which were dissection of the carotid artery. Others were laceration, hematoma and transection of the carotid arteries.

Many cases of rib fractures were reported due to shoulder belt application in frontal impacts. Two cases of decapitation were also reported. We report an unusual complete transection of the trachea with subsequent massive subcutaneous emphysema and death due to improper application of the automatic seat belt.

Acknowledgment

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