Roger E. Mittleman,[1] *M.D.*

Cervical Airway Injuries as a Result of Impact with Steering Wheel Rim

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ABSTRACT: Motor vehicle occupants may suffer severe cervical airway injuries as the result of impaction with the steering wheel, dashboard, windshield, backseat, and seat belt. Although the steering column is well recognized as a general site of injury infliction, less attention has been directed to components which may be the actual focal point of contact, such as the steering wheel rim. Two cases of cervical airway injury as a result of impact with the steering wheel rim are presented, including one instance of complete laryngotracheal transection. Correlation of injury with crash and postcrash sequences as well as the damaged vehicle will often provide excellent crash injury reconstruction.

KEYWORDS: pathology and biology, injuries, automobiles, accidents

Automobile accidents may uncommonly cause fatal laryngotracheal trauma in motor vehicle occupants. The well-known "padded dash syndrome" results when the head strikes the windshield and the neck simultaneously impacts into the dashboard [*1-3*]. Less commonly appreciated mechanisms of such trauma occur when the neck of the rear passenger strikes the back of the front seat [*4*] or the front seat occupant is ejected through the windshield [*5,6*]. Even seat belts may well be implicated as a factor in such injuries [*7*]. Although impact with the steering wheel is well accepted as a mode of intrathoracic trauma, less attention has been directed in the medical literature to the steering wheel rim as a contact site resulting in laryngotracheal injuries. The following case reports provide a rare documentation of the correlation of the vehicular compartment with cervical airway trauma caused by impaction with the steering wheel rim.

Case Report 1

A van collided with a multi-ton truck which allegedly had brake failure. Before the crash, the truck driver turned widely from a northbound lane into the westbound van, striking its left front (Figs. 1 to 3). As a result of the inward crush of the van's left front (Fig. 3), the steering column was pushed backward and upward such that the steering wheel rim was elevated and its perimeter was then moved within approximately 1 ft (0.3 m) from the top of the driver's seat (Fig. 4). After the crash, the van's driver (a 39-year-old black man) exited from the right side door, walked a few steps, and then collapsed.

Upon arrival of rescue personnel, the unresponsive victim was without respirations but had a faint carotid pulse (60/min). The neck was emphysematous and the trachea appeared

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[1]Associate medical examiner, Dade County Medical Examiner Department, and clinical associate professor of pathology, University of Miami School of Medicine, Miami, FL.

FIG. 1—*Multi-ton truck collided head-on with victim's van, thereby pushing van backward into adjacent lane.*

deviated. Laryngoscopic examination revealed "airway damage"; hence, an esophageal obturator was placed easily and satisfactorily. Subsequently, an endotracheal tube was also inserted with mild difficulty for transport via helicopter. At a local hospital emergency room, both airways were visualized within the esophagus. The esophageal obturator was removed and another endotracheal tube was inserted. Nevertheless, resuscitative efforts were unsuccessful.

Postmortem examination revealed a circumferential rent at the laryngotracheal junction combined with abundant blood in the trachea and proximal bronchial tree. The neck, however, was externally unremarkable. The cuff of the 7.5-cm endotracheal tube placed by the hospital staff was within the larynx, whereas an identical endotracheal tube placed by rescue

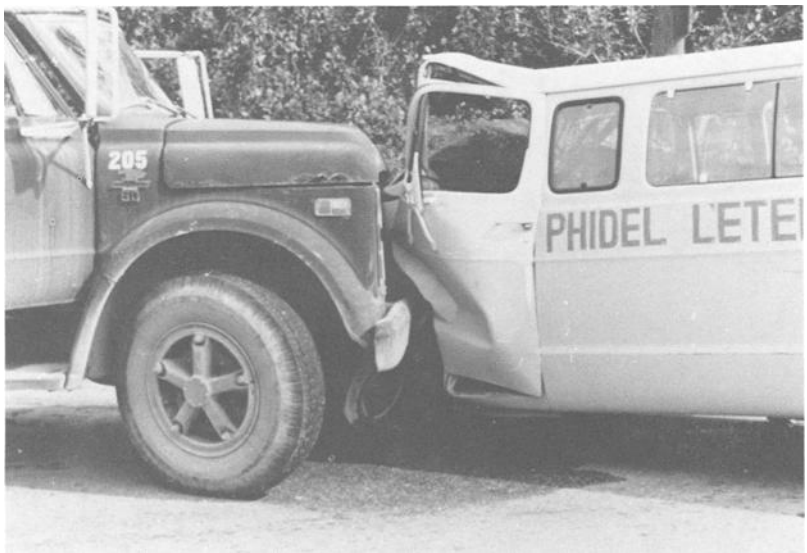

FIG. 2—*Front of truck struck left front of van during head-on collision.*

FIG. 3—*Inward crush of van's left front after head-on collision.*

workers had perforated the upper third of the esophagus and entered the laryngotracheal transection. Its cuff and distal tip were within the trachea (Figs. 5 to 6).

Postmortem dissection of the neck revealed a mild subluxation of cervical vertebra five under four with an underlying intact, swollen cervical cord. In addition, there was epidural blood extravasation at the subluxation site. Microscopy of the midcervical spinal cord revealed congestion, minute focal and perivascular intracordal blood extravasations, and also subarachnoid blood.

FIG. 4—*Van's steering column and steering wheel rim were pushed upward and backward at impact. Note that steering wheel rim is near top of driver's seat and at level of driver's neck. (Wide angle lens: 28 mm).*

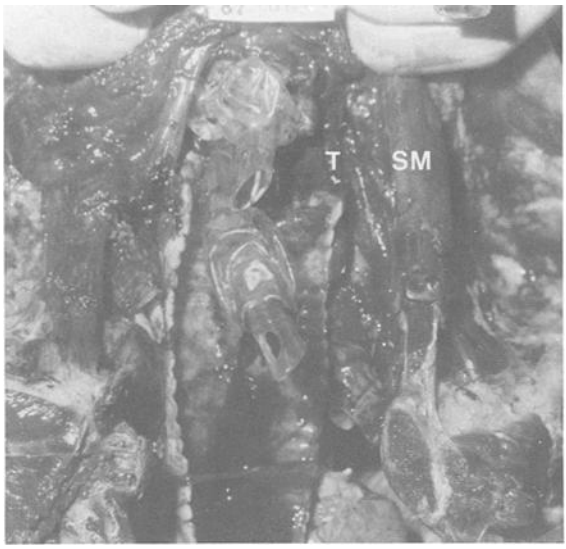

FIG. 5—*Laryngotracheal transection. (Skin of neck retracted upward). Upper endotracheal tube (with cuff in larynx) was inserted by hospital staff, whereas lower tube entered transection after iatrogenic perforation of esophagus. (*T = *transection,* SM = *sternocleidomastoid muscle.)*

The remainder of the autopsy revealed minor traumatic injuries (that is, lacerations of the chin, contusions and lacerations of the lips, abrasions of the left knee), pulmonary congestion, and cerebral edema. There was no evidence of significant preexisting natural disease. Standard toxicological testing failed to reveal evidence of alcohol, cocaine, or other drugs.

FIG. 6—*Laryngotracheal transection (skin of neck retracted upward) after removal of endotracheal tubes. Note blood in trachea. (*T = *transection,* SM = *sternocleidomastoic muscle.)*

Comment

At the time of the crash, the victim would have been thrust forward, his neck impacting the oncoming steering wheel rim and culminating in the traumatic laryngotracheal transection. The abundant blood in the tracheobronchial tree resulted in asphyxiation, which was the mechanism of death. Since the victim was able to walk out of the van, there was no definite evidence that the cervical spinal column injuries hastened his death. Also, the esophageal intubation did not contribute to his death, since the cuff would have blocked the accumulation of any additional tracheobronchial blood, and, in any event, was in its proper place within the airway.

Case Report 2

The driver of a station wagon was witnessed to take belated evasive action after striking a dog in the roadway. The vehicle swerved out of control into a cement power pole. Approximately 1 h later, the driver (a 38-year-old white man) was pronounced dead at a local hospital.

Upon radiologic examination of the skull, radiopaque material resembling bullet fragments were observed within the cranium. Postmortem examination revealed that the cause of death was a gunshot wound of the head. As a result of the vehicular crash, there was: (1) a steering column imprint-abrasion of the upper central chest (Fig. 7) with fractures of three anterior right ribs (1 to 3), underlying soft tissue hematoma, and small right hemothorax

FIG. 7—*Victim (Case 2) with steering column imprint on upper central chest and laceration of forehead.*

(50 mL); (2) fracture of both the left greater cornu and the right side of the body of the thyroid cartilage with adjacent soft tissue blood extravasation: (3) a 2-in. (5-cm) laceration of the left eyebrow; and (4) abrasions and bruises of the lower extremities. The remainder of the autopsy disclosed only moderate occlusive coronary arteriosclerosis. Toxicological studies revealed a blood ethanol concentration of 0.24%; there was no evidence of other drug usage.

Examination of the vehicle's interior revealed inward crush of the left front (Fig. 8). The top of the steering wheel rim had been pushed downward and backward, as well as closer to the steering column (Fig. 9).

Comment

The occupant was thrust forward, his chest striking the steering column and his throat impacting the adjacent steering wheel rim. The laryngeal injuries were secondary to the latter.

The driver was shot as the result of a verbal altercation with the occupant of another vehicle. It is necessary to examine traffic accident victims for other causes of death, and this case has been briefly presented elsewhere as a poignant reminder [*8*].

Discussion

Actual cases of cervical airway trauma as a result of steering wheel impaction are seldom encountered in the medical literature despite mention of such injuries in a number of articles [*1,2,9*]. In 1934, Taylor [*10*] reported an accident whereupon a motor vehicle collided head-on into a "street refuge" at about 30 to 40 mph (50 to 65 km/h). Immediately after the incident, the driver was found "with the steering wheel under his chin." A 1 1/2-in. (3.8-cm) transverse tear of the pretracheal muscles accompanied a torn trachea just below the cricoid cartilage. Facial and neck contusions and abrasions were encountered, although neck skin was intact. A nearly transected "bitten-through" tongue was also observed. In the absence of other injuries, the mechanism of death was attributed to pulmonary aspiration of blood secondary to bleeding from the tracheal and tongue injuries. Taylor's case is clearly similar to Case 1 of this presentation. The site of impact was presumably the steering wheel rim which was implied in this short report.

FIG. 8—*Inward crush of front of vehicle after head-on collision with power pole.*

FIG. 9—*Downward and backward displacement of steering rim after head-on collision. Compare steering column with chest imprint (Fig. 7) and location of rim with laryngeal injuries.*

In 1956, Beskin [*11*] described a complete cervicotracheal transection after impact with the "steering post," and in 1967, Michelson and Roque [*12*] reported a survivable steering wheel injury which culminated in a tracheoesophageal fistula at the level of the sternal notch. The exact site of the impact on the steering wheel was not directly specified in either of these two articles. Although it is commonly believed that many such fistulas and other airway injuries occur from striking the center of the steering wheel (that is, steering column), the steering wheel rim is well overlooked as an impact site. It must also be considered that both the column and rim may serve as a site for the simultaneous infliction of separate injuries. The latter is well exemplified in Case 2, whereupon after being shot, both chest and neck structures were traumatized.

In Case 1, postmortem discovery of an endotracheal tube within the esophagus prompted initial consideration of an iatrogenic transection since only a brief accident summary was immediately available. In fact, it was not known at the time of the autopsy that the victim had actually walked out of the van and then collapsed outside. Hence, the cervical subluxation with spinal cord injury was at first suspected as the main evidence of blunt trauma injury and, indeed, the proximate cause of death. However, since the endotracheal perforation would usually not be expected to cause a circumferential transection, further investigation was necessary. Only through careful reconstruction of the terminal events by witness interviews and inspection of the damaged van was it possible to exclude the endotracheal perforation of the upper esophagus as the cause of the transection. In fact, attention to the steering wheel was first mentioned by a rescue worker. An upper esophageal perforation site is often encountered in such mishaps as well as in patients with anatomical problems (for example, broad or short neck) or disease processes (for example, ankylosing spondylitis or arthritis) [*13*]. Indeed, the first rescue worker saw "airway damage" and used an esophageal obturator for this very reason. The same reason may well have resulted in the perforated esophagus by the endotracheal tube and passage by chance into the preexisting transection site. Although the esophageal obturator has also been reported as a cause of inadvertent esophageal perforation [*14–16*], it is obvious that it could not have caused the transection.

Fatal laryngotracheal trauma secondary to motor vehicle accidents is uncommonly encountered in forensic pathology. Kemmerer et al. [*17*] tabulated only 5 instances of tracheal rupture in 585 traffic fatality victims from 1 May 1954, through 30 April 1959. In addition,

only 12 patients with cervical airway injury secondary to traffic accidents were treated at Montreal General Hospital from 1 Jan. 1974 to December 1984 [*18*]. Furthermore, only 8 complete transections of the cervical airway [*1,3–7,11,19*] were encountered during this review of the medical literature. Hence, the pathologist is often confronted with atypical injuries that are not only seldomly observed, but also rarely assigned to an exact impact site within the motor vehicle. Direct scene investigation is usually the best method to correlate injury with the damaged vehicle. Alternatively, inspection of the vehicle even after extraction from the scene combined with police photographs may well provide useful information.

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Address requests for reprints or additional information to
Roger E. Mittleman, M.D.
Dade County Medical Examiner Department
1 Bob Hope Rd.
Miami, FL 33136