EMBJ.ORG FOR YOUNG DOCTORS

EUROMEDITERRANEAN BIOMEDICAL JOURNAL
2019,14 (25) 110–113
(*FORMERLY: CAPSULA EBURNEA*)

Original article

IDENTIFICATION OF DRIVER AND FRONT PASSENGER IN TRAFFIC ACCIDENTS THROUGH ORGAN LESION INJURY PATTERN.

Matteo Solinas [1], Enrico Silingardi [1], Francesco Raschellà [2], Mauro Liciani [3], Bartolo Caggiano [2], Valeria Marino [2], Silvestro Mauriello [2], Saverio Potenza [2], Gian Luca Marella [4]

1. Unit of Forensic Medicine, Department of Diagnostic, Clinical and Public Health Medicine, University of Modena and Reggio Emilia.
2. Department of Biomedicine and Prevention, Section of Legal Medicine, Social Security and Forensic Toxicology, University of Rome Tor Vergata.
3. Data Scientist Consultant.
4. Department of Surgical Sciences, Section of Legal Medicine,University of Rome Tor Vergata.

ARTICLE INFO

Article history:
Received 26 March 2019
Revised 18 June 2019
Accepted 19 July 2019

Keywords:
traffic accident, driver, front passenger, organ lesion injuries, traffic medicine.

ABSTRACT

Through a retrospective study, 328 bodies of deceased car drivers were examined (252 drivers and 76 passengers seated in the front seat). Specifically, lesions of the cranial, thoracic and abdominal organs were examined. The purpose of the study is to ascertain whether it is possible to identify, through the organ lesion injury pattern, who was driving at the time of the traffic accident. Statistical analysis was used to detect injuries that could discriminate between the driver and front passenger. Among the drivers, lesions of the thoracic organs were more frequently observed, in accordance with the greater skeletal lesivity (specifically in the sternal), due to the impact with the steering wheel; even the injury of the abdominal organs has more frequently affected the driver than the front passenger. The encephalic lesion effected the driver and front passenger in a similar percentage of cases. As it was imaginable to think, the thoracic lesions were the most effective to differentiate the driver from the front passenger. Abdominal lesion also plays an important role in the study, having been observed in the driver with a doubled frequency compared to the front passenger.

1. Introduction

Mortality resulting from a traffic accident in the general population is in third place after cardiovascular and neoplastic diseases and ranked first in the population under the age of 35 in Italy. Road accidents are the most frequent cause of traumatic death [1-3]. Based on the most recent data published in 2015, 173,892 car accidents causing personal injuries occurred in 2015, resulting in 3,419 deaths (within 30 days from the accident) and 246,050 injured persons. The year 2015 was marked by a new increase in car accident victims in Italy and in the European Union (1.3% more than in 2014, but a marked decrease compared to 2011).
For every million people, 52 road accident deaths occurred in 2015 in the EU28 and 56.3 in Italy, which is 14th in the European ranking, behind the United Kingdom, Spain, Germany and France [4, 5].

Law number 41 of March 23, 2016, published in the Gazetta Ufficiale on March 24th and enforced the following day, introduced the road killing into the Italian legal system. This is nothing more than a particular case of manslaughter that occurs every time one of the behaviors specifically identified by art. 589 bis c. p., which are based on violations of certain regulations governing road traffic. The increase in punishment in the event of road killing has meant that the driver of the motor vehicle involved in an accident in which the death of the person transported (sitting in the front seat) has voluntarily replaced itself with the latter in order to to take responsibility for the event. From this derives the need to proceed to appropriate legal medical investigations to establish who at the time of the accident was really driving the motor vehicle.
Hence the reason for the study: after observing in a previous work [6] the role of skeletal injury in determining the dynamics of the road accident,

Corresponding author: Matteo Solinas, *matteo.solinas25@gmail.com*
DOI: 10.3269/1970-5492.2019.14.25
 ISSN: 2279-7165 - Available on-line at www.embj.org

the objective is to verify on a strictly medical-legal level if, also through the examination of the damage to the internal organs resulting from a car accident, there is the possibility of distinguishing the driver from the front passenger transported at the time of the accident.

2. Material and methods

328 corpses of subjects who died between 2000 and 2016 were examined following motor vehicle accidents, 252 drivers and 76 passengers seated in the front seat, which occurred in the territory of Rome and Rome's province, assessing the dynamics of the road accident (frontal shock pole), right side, left side and rear, considering all cars were equipped with the same safety system (belts and air-bags).At the same time, on the statistical level, possible confounding factors (advanced age of the patient) that could have influenced the result were eliminated.

The 328 corpses were subjected to necroscopic examination. The lesion of the internal organs of the driver and of the front passenger has been studied, reported at the level of the skull (intraparenchymal, subdural and subarachnoid lesions), of the thorax (aortic, cardiac and pulmonary lesions) and of the abdomen (hepatic, splenic lesions, renal, gastric, intestinal) in which the pelvis was also included, given the close anatomical correlation (bladder lesions). For the two distributions (driver-passenger) classical statistical values were considered: 1) degrees of freedom, 2) average and 3) standard deviation, from which the following parameters were derived: Pearson's Curtosis (to verify the overlap of the distributions with respect to the Gaussian), asymmetry of Fischer (to identify possible oscillations of asymmetry with respect to the Gaussian) and Covariance (to confirm the correlation between the two distributions). Asymmetries have slight fluctuations, always in agreement for both distributions. Data relating to the driver and to the transported person are homogeneous and always maintain the same tendencies of Curtosi and Asimmetria. The positive values of the Covariance show a correlated and concordant behavior for the two distributions. Finally, the T-Student and Chi square tests were performed to verify the validity of the statistical sample available. The T-Student, useful for the study of the homogeneity of the distributions, in the case in question has validity for values lower than 5%.

This value is maintained in all the examined body areas, except for the thorax. This data can be attributed to the presence of the steering wheel. Chi square (similarity of distributions) confirms the results already obtained by T-Student (Table 1 and 2).

Driver	*Mean*	± *Standard Deviation*	**Passenger**	*Mean*	± *Standard Deviation*	**T Student**	**Chi-Square**
SKULL	20.50	17.23	SKULL	6.50	4.43	3.15	9.56
CHEST	20.00	7.48	CHEST	1.00	1.15	10.04	18.05
ABDOMEN	16.57	20.52	ABDOMEN	2.86	3.63	4.61	11.35

Table 1. Analysis of lesions of the thoracic organs pattern asymmetry.

Anatomical Sites	**n**	**%**
SKULL	108 (82 drivers/26 passengers)	32.9%
CHEST	84 (80 drivers/4 passengers)	25.6%
ABDOMEN	136 (116 drivers/20 passengers)	41.4%

Table 2. General distribution of internal lesions in drivers and passengers.

3. Results

Overall, both the driver's and the front passenger's skull was affected by encephalic lesions in 32.9% of cases, chest in 25.6% of cases and abdomen in 41.4% of cases (Table 3).

ANATOMICAL SITES	**SUBDISTRICT**	**DRIVER**	**PASSENGER**	**TOTAL**
SKULL	INTRA-PARENCHYMAL	18	10	28
	EXTRA-PARENCHYMAL	0	0	0
	SUBDURAL	22	8	30
	SUBARACHNOID	42	8	50
CHEST	AORTA	22	2	24
	HEART	28	0	28
	RIGHT LUNG	20	0	20
	LEFT LUNG	10	2	12
ABDOMEN	LIVER	56	10	66
	SPLEEN	34	4	38
	RIGHT KIDNEY	2	0	2
	LEFT KIDNEY	4	0	4
	STOMACH	6	0	6
	INTESTINE	8	2	10
	URINARY BLADDER	6	4	10

Table 3. Number and types of internal injuries among drivers and passengers

The driver's brain was affected by injury in 82 cases out of the total 252; in particular, intraparenchymal encephalic lesions were observed in 18 subjects (7%), subdural encephalic lesions in 22 subjects (9%) and subarachnoid encephalic lesions in 42 subjects (17%).The transported brain was affected in 26 cases out of the total 76: in 10 subjects intraparenchymal encephalic lesions (13%) have been identified, in 8 subjects subaucal encephalic lesions (10%) and in as many as 8 subjects subarachnoid encephalic lesions (10%)) (Table 4 and 5). Thoracic lesions involved 80 drivers and 4 carried. Aortic lesions were observed in 22 drivers (9%) and 2 transported (3%), cardiac lesions in 28 drivers (11%) and in none transported (0%), right lung injuries in 20 drivers (8%) and in no way transported (0%) the left lung lesions in 10 drivers (4%) and 2 transported (3%) (Table 4).

	Driver	Passenger
SKULL		
intraparenchymal encephalous	7%	13%
extraparenchymal encephalous	0%	0%
subdural encephalous	9%	10%
encefalo-subarachnoid	17%	10%
CHEST		
aorta	9%	3%
heart	11%	0%
right lung	8%	0%
left lung	4%	3%
ABDOMEN		
liver	22%	12%
spleen	13%	5%
right kidney	1%	0%
left kidney	1%	0%
stomach	2%	0%
intestine	3%	3%
urinary bladder	2%	5%

Table 4. Distribuition of internal injuries in the different anatomical sites between drivers and passengers

Lesions of the abdominal organs were observed in 116 drivers and 20 previously transported. Lesions affected the liver in 56 drivers (22%) and 10 transported (12%), the spleen in 34 drivers (13%) and 4 passengers (5%), the right kidney in 2 drivers (1%) and in no passengers, the left kidney in 4 drivers (1%) and in no passengers, the stomach in 6 drivers (2%) and in no passengers, the intestine in 8 drivers (3%) and in 2 passengers (3 %) and, finally, the bladder in 6 drivers (2%) and 4 passengers (5%) (Table 4). Thus, the driver's brain was affected by lesions in 32.5% of cases, thorax in 31.7% of cases and abdomen in 46% of cases. In the anterior transport, in 34% of cases the brain was involved, in 5.2% of cases thorax and in 26.3% of cases abdomen (Table 3).

The statistical processing of the data took into account the simultaneous presence in the examined bodies of several internal lesions within the same body district (eg simultaneous presence of aortic and cardiac lesions, etc.). Dynamics of the accident and then the shock pole were then taken into consideration; in the event of an incident with a frontal impact pole, the difference in the lesion of the thoracic and abdominal organs between the driver and the passenger becomes even more evident.

4. Discussion

The aim of this work, in the wake of the previous one carried out on the skeletal injury, is to establish whether it is possible to differentiate the driver from the front passenger in the event of a fatal motor accident [6-12]. In fact, more and more often, especially in Italy with the introduction into the legal system of the road killing, the driver who survived the car crash claims to be transported in order to avoid criminal proceedings. Curtin et al. [13] observed a different injury between driver and passenger. In particular, the most frequent injuries in the drivers were the brain, fractures of the right femur, the posterior arch of the right ribs, the cranial base, the right humerus and the right shoulder, while in the front passengers were splenic lesions, fractures of the posterior and anterior arch of the left ribs, of the left shoulder and of the left femur. Based on these investigations, the authors provided a predictive model of differential diagnosis with an accuracy of 69.3%. From our study we can see that what is most important is the lesion of the thoracic organs and secondly the lesion of the abdominal organs. Statistical data confirm that the most valid character to differentiate the driver (31.7% of cases) from the front passenger (5.2% of cases) is precisely the lesion of the thoracic organs.

The explanation of this phenomenon was motivated by the presence of the steering wheel [14], responsible for the increased skeletal lesion at the sternal level, and therefore by referring to the greater lesion of the thoracic organs. T-Student, useful for the study of the homogeneity of the distributions, has validity for values lower than 5%; in our case, the only parameter that exceeds said value refers to the thoracic district and can be explained on the basis of an intrinsic difference in the two categories of study, namely, the presence in the cockpit of the steering wheel that concerns only the driver's side. The presence of the steering wheel makes the two distributions asymmetrical, and most probably explains the different lesions found at the level of the thorax. This difference assumes fundamental importance in the differential diagnosis between the driver and the transported (the higher the thoracic lesivity in the first). As for the other anatomical areas analyzed, greater lesion of the abdominal organs was observed in the driver compared to the front passenger (liver 22% in the driver vs. 12% of the front passenger, spleen 13% of the driver vs 5% of the front passenger). Instead, bladder lesions more frequently involved anterior transport (5%) than the driver (2%). The same has been observed in the skeletal lesion study, which shows a greater incidence of pelvic fractures in the anterior transport compared to the driver.

5. Conclusions

The present study shows that the examination of the lesion of internal organs in car accident cases is a useful tool for the identification of the driver and the front passenger, as well as for the study of skeletal injury.In particular, according to what was observed in the examination of the skeletal injury, the study establishes that the lesion of the thoracic organs is the most valid element to differentiate the driver from the front passenger. At the same time, the anterior passenger is more frequently subject to lesions of the abdominal organs, while the encephalic lesion presents a similar frequency. Finally, an increased incidence of bladder lesion compared to the driver was observed in the anterior transport, and always in accordance with what was observed for skeletal injury (pelvic fractures).

References

1. Van Masullo A, Feola A, Marino V, Iadevaia C, TrabuccoAurilio M, Marsella LT: Sleep disorders and driving licence: The current Italian legislation and medico-legal issues. La Clinica Terapeutica 2014; 165 (5):e368-372.
2. Sorrentino S, Marsella LT, Feola A, Marino V, Billi B: Penetrating ocular trauma with retained intraocular foreign body: Management, follow-up and medico-legal evaluation. West Indian Medical Journal 2016; 65(2): 391-394

3. Lagravinese GM, Mammone A, Mammone A, Rossi C, De Vita M, Marino V, Feola A, Marsella LT: The frequency of polidrug use in a driving population in Rome. Epidemiology Biostatistics and Public Health 2015; 12: e1-e7.
4. ISTAT: Incidenti stradali in Italia dati provvisori. Available from: www.istat.it/it/archivio/189322; (last accessed 06.09.2017)
5. Feola A, Marino V, Sorrentino S, Marsella LT: Medico-legal and traumatological aspects of orbital fractures: A case report. EuroMediterraneanBiomedical Journal 2013; 8 (23):140 – 145.
6. Marella GL, Solinas M, Potenza S, Milano F, Manciocchi S, Perfetti E, Raschellà F, Liciani M, Caggiano B, Mauriello S:Identification of driver and front passenger in trafficaccidentsthroughskeletalinjury pattern. EuroMediterranean Biomedical Journal 2018, 13 (01): 1-4.
7. Smock WS, Nichols GR, Fuller PM, Weakley-Jones B: The forensic pathologist and the determination of driver versus passenger in motor vehicle collisions. The need to examine injury mechanisms, occupant kinematics, vehicle dynamics, and trace evidence. Am J Forensic Med Pathol 1989; 10 (2):105-14.
8. Păduraru G, Knieling A, Scripcaru C, Iliescu DB: A possibility to identify the vehicle driver through complex forensic and criminalistic expertise - case report. Rev Med Chir Soc Med Nat Iasi 2014; 118 (4):1108-13.
9. Smirenin SA, Khabova ZS, Fetisov VA: The possibilities for determining the passenger position inside the car passenger compartment based on the injuries to the extremities estimated with the use of the sequential mathematical analysis. Sud Med Ekspert 2015; 58 (3):29-35.
10. Habova K, Smirenin E, Fetisov D, Tamberg E: The use of the sequential mathematical analysis for the determination of the driver's seat position inside the car passenger compartment from the injuries to the extremities in the case of a traffic accident. Sud MedEkspert 2015; 58 (2):17-21.
11. Caggiano B, Marella GL, Treglia M, Milano F, Mancuso A, Solinas M, Marsella LT, Feola A: Type II odontoid fracture: a case report and a correct medico-legal evaluation. EuroMediterraneanBiomedical Journal 2018, 13 (32): 142-144
12. Fetisov VA, Gusarov AA, Smirenin SA: The peculiar features of conducting comprehensive expertises of the injuries inflicted inside the passenger car compartment. Sud Med Ekspert2016; 59 (4):15-20.
13. Curtin E, Langlois NE: Predicting driver from front passenger using only the postmortem pattern of injury following a motor vehicle collision. Med Sci Law 2007; 47 (4):299-310.
14. Newgard CD, Lewis RJ, Kraus JF: Steering wheel deformity and serious thoracic or abdominal injury among drivers and passengers involved in motor vehicle crashes. Ann Emerg Med2005; 45 (1):43-50.