

Comparative analysis of the frequency and the severity of diagnosed lesions between pedestrians struck by motor vehicles and other blunt trauma mechanisms victims

Análise comparativa das lesões diagnosticadas e de sua gravidade entre vítimas de atropelamento e outros mecanismos de trauma fechado

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A B S T R A C T

Objective: to compare the frequency and the severity of diagnosed injuries between pedestrians struck by motor vehicles and victims of other blunt trauma mechanisms. **Methods:** retrospective analysis of data from the Trauma Registry, including adult blunt trauma patients admitted from 2008 to 2010. We reviewed the mechanism of trauma, vital signs on admission and the injuries identified. Severity stratification was carried using RTS, AIS-90, ISS e TRISS. Patients were assigned into group A (pedestrians struck by motor vehicle) or B (victims of other mechanisms of blunt trauma). Variables were compared between groups. We considered $p < 0.05$ as significant. **Results:** a total of 5785 cases were included, and 1217 (21,0%) of which were in group A. Pedestrians struck by vehicles presented ($p < 0.05$) higher mean age, mean heart rate upon admission, mean ISS and mean AIS in head, thorax, abdomen and extremities, as well as lower mean Glasgow coma scale, arterial blood pressure upon admission, RTS and TRISS. They also had a higher frequency of epidural hematomas, subdural hematomas, subarachnoid hemorrhage, brain swelling, cerebral contusions, costal fractures, pneumothorax, flail chest, pulmonary contusions, as well as pelvic, superior limbs and inferior limbs fractures. **Conclusion:** pedestrian struck by vehicles sustained intracranial, thoracic, abdominal and extremity injuries more frequently than victims of other blunt trauma mechanism as a group. They also presented worse physiologic and anatomic severity of the trauma.

Key words: Accidents, Traffic. Multiple Trauma. Trauma Severity Indices. Accident Prevention. Wounds and Injuries.

INTRODUCTION

Road vehicle accidents are a major public health problem worldwide. Such accidents constitute the eighth leading cause of death, accounting for 1.24 million fatalities per year¹. Road accidents are the leading cause of death among young individuals aged 15-29 years. The majority of these deaths occur in underdeveloped or developing countries².

Pedestrians account for 22% of victims of road accidents globally and 20% in Brazil^{2,3}. Brazilian mortality rates in this subgroup have remained constant (at around 20 deaths per 100,000 persons), despite a more than 200% increase in the fleet of vehicles in the past 15 years (DENATRAN)⁴. According to data from *DATASUS*, the number of pedestrian deaths remained at a relatively stable absolute rate over the past decade (9,000-10,000 deaths/year) but has declined proportionally: from 36% in

1998 to 20% in 2011, explained by the fact that motorcyclists and cyclists now represent a larger proportion of overall traffic-related deaths^{3,5}. The most common lesions in individuals struck by vehicles are musculoskeletal and head injuries, depending on the population studied^{6,7}. According to Hefny *et al.*, in 2014, the main cause of death was severe traumatic brain injuries⁸. Few studies have investigated long-term sequelae in this patient group. The disability rate is believed to be high but national data remains scarce.

A search of the available literature revealed no studies comparing the rate and severity of injuries among pedestrians struck by vehicles versus patients with other mechanisms of blunt trauma. This data could be valuable in assisting first-responders to establish adequate triage procedures and promoting more rational use of complementary exams, allocating the resources available to the treatment of these patients. The

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objective of the present study was to compare the rate and severity of injuries diagnosed in pedestrians struck by vehicles *versus* patients with other mechanisms of blunt trauma.

METHODS

A retrospective analysis of the information stored on the database of the emergency service was carried out based on data collected prospectively from a trauma registry for quality control between 2008 and 2010. All blunt trauma patients older than 13 years of age admitted to the emergency service were selected for the analysis. This study was submitted to the Research Ethics Committee of the institution and approved under process number 914.477.

Information was collected on trauma mechanism, vital-signs on admission, complementary exams performed, injuries diagnosed, along with their severity and management. Severity of the sample was stratified using the following trauma indexes: Revised Trauma Score (RTS)⁹, Abbreviated Injury Scale 1990 (AIS)¹⁰, Injury Severity Score (ISS)¹¹ and probability of survival calculated by the TRISS method¹². Severe injuries were defined as those with AIS>3 in the different body segments.

Trauma patients were split into two groups: Group A- pedestrians struck by motor vehicles; Group B- patients with other mechanisms of blunt trauma, including motorcyclists involved in road traffic accidents, occupants of four-wheeled vehicles, falls, physical assault, cyclists and associated mechanisms.

Variables for the two groups were compared to identify the specific characteristics of pedestrians struck by vehicles. The statistical analysis was performed using the Chi-square or Fisher's exact tests for qualitative variables and Student's *t*-test and Mann-Whitney test for quantitative variables, according to the distribution of the sample. A value of $p < 0.05$ was considered significant.

RESULTS

Data from 5,785 blunt trauma patients was included in the study. Mean age of patients was 39.3 ± 17.1 years. The most common trauma mechanisms were: accidents involving motorcyclists, being struck by a road vehicle, falls from the same level, falls from height, physical assault, automobile accidents involving occupants of four-wheeled vehicles and associated mechanisms (Table 1). The means and standard deviations on the RTS, ECG, ISS and TRISS indexes for the sample analyzed were: 7.6 ± 0.9 , 14.6 ± 2 , 4.6 ± 8 , and 0.99 ± 0.4 , respectively. Comparison of the groups showed that pedestrians struck by vehicles had significantly ($p < 0.05$) greater mean age, mean heart rate on admission, lower mean Glasgow coma scale, systolic arterial pressure on admission, lower arterial hemoglobin saturation (pulse oximetry) on admission a greater mean AIS in the head, thorax, abdomen and in extremities segments (Table 2). With regard to the trauma scales, Group A patients had a higher mean score on the ISS, and lower mean score on both the RTS and the TRISS (Table 2).

Group A patients had a significantly ($p < 0.05$) higher rate of extradural hematomas, acute subdural hematomas, traumatic subarachnoid hemorrhage, brain contusion, diffuse axonal injury, brain swelling, hemothorax, rib fractures, pneumothorax, flail chest, lung contusion, pelvic fractures, upper limb fractures, lower limb fractures and lower limb open fractures (Table 3). Also in Group A, a greater need for orotracheal intubation (5.3% vs. 2.3%) and closed chest drainage on admission (2.7% vs. 1.3%) ($p < 0.05$) were noted. Lethality was significantly higher in Group A (4.3% vs. 1.5%).

DISCUSSION

Vehicle-pedestrian accidents result from a variety of different factors. Many of these factors are associated with local conditions and others with individual behavior. Signage conditions at the scene of the accident are directly

Table 1 - Trauma mechanism.

Trauma mechanism	Number	%
Motorcyclists	1390	24%
Struck by vehicle	1217	21%
Fall from the same level	997	17.2%
Fall from height	734	12.7%
Physical assault	646	11.2%
Driver or passenger of four-wheeled automobile	552	9.5%
Associated mechanisms	249	4.3%
TOTAL	5785	100%

Source: Serviço de Emergência da Irmandade da Santa Casa de Misericórdia de São Paulo (2008-2013).

Table 2 - Comparison of quantitative variables for Group A (pedestrians struck by vehicle) versus Group B (patients with other mechanisms of blunt trauma). Data expressed as mean/standard deviation.

Variable	Group A N= 1217	Group B N=4568	p
Age	41.7 ± 17.8	38.6 ± 17.7	< 0.001
SAP on admission	127 ± 27.6	128.7 ± 21	0.041
HR on admission	84.5 ± 15.8	82.7 ± 13.8	< 0.001
RR on admission	17.5 ± 4.8	17.4 ± 3.9	0.707
GCS on admission	13.5 ± 2.6	14.3 ± 1.9	< 0.001
Sat on admission	95.3 ± 7	96 ± 5.1	0.042
ALS head	0.77 ± 1.3	0.56 ± 1	< 0.001
ALS thorax	0.22 ± 0.8	0.12 ± 0.59	< 0.001
ALS abdomen	0.17 ± 0.7	0.09 ± 0.57	0.001
ALS extremities	1.22 ± 1.31	0.81 ± 1.1	< 0.001
RTS	7.49 ± 1.2	7.67 ± 0.7	< 0.001
ISS	6.8 ± 10.3	3.9 ± 7.1	< 0.001
TRISS	0.98 ± 0.08	0.99 ± 0.32	0.035

Source: Serviço de Emergência da Irmandade da Santa Casa de Misericórdia de São Paulo (2008-2013).

Age in years; SAP, Systolic Arterial Pressure in millimeters of mercury; RR, respiratory rate in breaths per minute; HR, heart rate in beats per minute; GCS, Glasgow coma scale; Sat, Oxygen saturation, in percentage; ALS, Abbreviated Injury Scale; RTS, Revised Trauma Score; ISS, Injury Severity Score; TRISS, calculation of probability of survival in trauma.

Table 3 - Comparison of qualitative variables for Group A (pedestrians struck by vehicles) versus Group B (patients with other mechanisms of blunt trauma).

Variable	Group A N= 1217	Group B N=4568	P
Orotracheal intubation	65 (5.3%)	119 (2.6%)	<0.001
Chest drainage	33 (2.7%)	60 (1.3%)	0.001
Extradural hematoma	30 (2.5%)	62 (1.4%)	0.006
Acute subdural hematoma	67 (1.5%)	35 (2.9%)	0.001
Subarachnoid hemorrhaging	48 (3.9%)	75 (1.6%)	<0.001
Brain contusion	57 (4.7%)	98 (2.1%)	<0.001
Diffuse axonal injury	19 (1.6%)	24 (0.5%)	<0.001
Brain Swelling	18 (1.5%)	24 (0.5%)	<0.001
Craniotomy	32 (2.6%)	68 (1.5%)	0.007
Hemothorax	26 (2.1%)	61 (1.3%)	0.070
Pneumothorax	31 (2.5%)	67 (1.5%)	0.030
Rib fractures	54 (4.4%)	109 (2.4%)	<0.001
Flail chest	26 (2.1%)	31 (0.7%)	<0.001
Lung contusion	36 (3%)	55 (1.3%)	<0.001
Pelvic fracture	42 (3.5%)	50 (1.1%)	<0.001
Upper limb fracture	77 (6.3%)	188 (4.1%)	0.005
Lower limb fracture	107 (8.8%)	190 (4.2%)	<0.001
Upper limb open fracture	10 (0.8%)	51 (1.1%)	0.37
Lower limb open fracture	63 (5.2%)	99 (2.2%)	<0.001
Lethality	52 (4.3%)	69 (1.5%)	<0.001

Source: Serviço de Emergência da Irmandade da Santa Casa de Misericórdia de São Paulo (2008-2013).

correlated with pedestrian trauma. Generally, in rural areas there is less signage and abundance with traffic laws¹³. Vehicle type and design are also associated with pedestrian patient outcomes. Countries such as the USA, where there is culture

of using pick-up type automobiles, tend to have higher impact trauma compared to European countries, in which urban compact automobiles predominate^{14,15}. The most severe traumas typically occur at nighttime when visibility

on the roads is poorer. Associated factors such as higher rate of drunkenness, whether among drivers or pedestrians, clearly contributes to this statistic¹⁶.

Based on the data analyzed in the present study, vehicle-pedestrian accidents were responsible for 21% of the blunt trauma cases seen at the central emergency room of the *Santa Casa de Misericórdia de São Paulo* hospital. This rate is comparable with the figure of 20% published by *DATASUS*³ and represents the second-most-common mechanism of trauma seen at the service after motorcyclists. It is noteworthy that the majority of vehicle-pedestrian accidents result from breaches of safety such as crossing the street without using pedestrian crossings and also imprudence by drivers. Therefore, preventive measures can play a vital role given the frequency of this trauma mechanism.

There are several factors associated with the severity and prognosis of injured pedestrians¹⁷. Speed of impact and weight of the vehicle are reported as factors determining poorer prognoses¹³. The risk of a pedestrian sustaining injury with AIS>3 is 10% at an impact velocity of 17.1mph yet may be as high as 90% at 54.6mph¹³. Greater severity injuries and higher lethality have been reported in pedestrians struck by heavier vehicles such as pick-ups and sports utility vehicles (SUV)¹⁵.

One of the largest series in the literature highlighted age as one of the major factors related to mortality among pedestrians injured by automobiles^{8,18}. Indeed, the influence of age, together with its physiological repercussions and weaker defense reflex mechanism, on morbidity and severity of trauma patients in general has been demonstrated¹⁹. Injuries in this subgroup are also more severe, especially those involving the head and spinal column. Peng e Bongard, in 1999, showed a relationship between older age and higher ISS on admission, longer hospital stay and greater need for intensive care⁷. Other study has also shown greater injury severity with advancing age¹⁸. Apparently, lethality is greater in older than younger adults, despite having similar ISS on admission²⁰. In the present study, mean age of pedestrians struck by vehicles was higher than that of patients with other mechanisms of blunt trauma. This finding is in line with earlier studies showing that vehicle-pedestrian accidents were the second-most-common cause of trauma in older-old aged 70 years and over and the leading cause among older adults aged 60-70 years²¹. The importance of prevention, specifically in this group highly vulnerable to such trauma, is clear.

In the present sample, mean ISS was 6.8 for the pedestrian group, which had lethality of 4.3%. Thus, the majority of patients did not have serious injuries. McElroy *et al.*, in 2013, reported a mean ISS of 12, around double the rate found in the present investigation²⁰. Other studies also reported higher injury rates and severity in pedestrian groups compared to the present sample^{22,23}. It should be pointed out that the severity of the sample depends essentially on the triage of patients to be attended at a

given service. These data suggest, given that Santa Casa is a University Teaching Hospital, there is clearly overtriage of patients, hampering the running of the emergency service as a whole.

Although several studies have analyzed the evolution of pedestrians struck by vehicles, no studies comparing the severity of injuries with other mechanisms of blunt trauma were found. The data of the present study suggests that pedestrians struck by vehicles more frequently sustain certain types of injuries. A higher rate of intracranial injuries (extradural hematomas, acute subdural hematomas, subarachnoid hemorrhage, diffuse axonal injury, Brain Swelling, brain contusion), thoracic injuries (hemothorax, pneumothorax, rib fractures and lung contusion) and injuries to extremities (open and closed fractures) was observed. Pelvic fractures, recognized as a marker of severity in trauma, were also more prevalent in pedestrian patients. Anatomical severity of the trauma was greater for all body segments, evidenced by comparing mean AIS scores. Physiological (RTS) and anatomical (ISS) scales, as well as probability of survival (TRISS) measures, indicated greater trauma severity among this patient group. The pedestrians struck by vehicles exhibited higher mean heart and respiratory rates on admission and also lower mean GCS score. This is associated with the higher rate of orotracheal intubation and chest drainage seen in the pedestrian group compared to the patient group with other blunt trauma mechanisms. These two variables are indicative of greater severity, corroborating previous findings. The direct impact to which pedestrians struck by vehicles are subjected, in the absence of protective equipment, probably leads to potentially more serious injuries. This finding closely mirrors the data reported in both national and international literature²²⁻²⁷.

The knowledge that pedestrians struck by vehicles have specific characteristics, differentiating them from patients with other trauma mechanisms, is important from a clinical and epidemiological standpoint. Besides being the second-most-common mechanism of blunt trauma in the Brazilian milieu, vehicle strikes are potentially more serious than other mechanisms and affect older age groups. This warrants special attention from authorities. When dealing with a pedestrian struck by a vehicle, first-responders should be alert to the greater likelihood of severe injuries and physiological decompensation requiring immediate invasive procedures in the trauma room. A high level of suspicion for internal injuries, especially TBI and thoracic injuries should guide complementary exams. This information is also useful for the pre-hospital care and stabilization teams, since triage of these patients should take into account the greater severity associated with this type of trauma mechanism. Epidemiologically, wide discussion is necessary for the implementation of preventive measures, since this constitutes a potentially avoidable mechanism, yet one that is associated with greater risk of hospitalization, invasive procedures and death.

In conclusion, pedestrians struck by vehicles have a higher rate and severity of intracranial, thoracic, abdomi-

nal and extremity injuries compared to patients with other mechanisms of blunt trauma.

R E S U M O

Objetivo: comparar, entre vítimas de atropelamento e de outros mecanismos de trauma fechado, a frequência e gravidade das lesões identificadas. **Métodos:** análise retrospectiva das informações do registro de trauma, incluindo as vítimas de trauma fechado, com idade superior a 13 anos de idade, admitidas entre 2008-2010. Avaliamos o mecanismo de trauma, dados vitais à admissão e lesões diagnosticadas. A estratificação de gravidade da amostra foi realizada pelos índices RTS, AIS-90, ISS e TRISS. As vítimas de trauma fechado foram separadas em dois grupos: Grupo A- pedestres vítimas de atropelamento; Grupo B- vítimas dos demais mecanismos de trauma fechado. As variáveis foram comparadas entre os dois grupos. **Resultados:** foram incluídos no estudo 5785 casos, sendo que, 1217 (21,0%) foram vítimas de atropelamento. Observamos que os traumatizados do grupo A apresentaram, significativamente ($p < 0,05$), maior média etária, de frequência cardíaca à admissão, de ISS, de AIS no segmento cefálico, torácico, abdominal e em extremidades, bem como, menor média de escala de coma de Glasgow, pressão arterial sistólica a admissão, RTS e TRISS. As vítimas de atropelamento também apresentaram ($p < 0,05$), maior frequência de hematomas extradurais, hematomas subdurais agudos, hemorragia subaracnoidea, Brain Swelling, contusão cerebral, lesão axonal difusa, fraturas de arcos costais, pneumotórax, tórax flácido, contusão pulmonar, bem como, fraturas de pelve, de membros superiores, inferiores e expostas de membros inferiores. **Conclusão:** as vítimas de atropelamento apresentam maior frequência e gravidade de lesões intracranianas, torácicas, abdominais e em extremidades quando comparadas às vítimas de outros mecanismos de trauma fechado em conjunto.

Descritores: Acidentes de Trânsito. Traumatismo Múltiplo. Índices de Gravidade do Trauma. Prevenção de Acidentes. Ferimentos e Lesões.

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