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Trauma mechanism predicts the frequency and the severity of injuries in blunt trauma patients

Relação entre o mecanismo de trauma e lesões diagnosticadas em vítimas de trauma fechado

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ABSTRACT

Objective: *to study the correlation of trauma mechanism with frequency and severity of injuries in blunt trauma patients.* **Methods:** *retrospective analysis of trauma registry in a 15-month period was carried out. Trauma mechanism was classified into six types: occupants of four-wheeled vehicles involved in road traffic accidents (AUTO), pedestrians struck by road vehicles (PED), motorcyclists involved in road traffic accidents (MOTO), falls from height (FALL), physical assault with blunt instruments (ASSA) and falls on same level (FSL). Injuries with AIS>2 were considered severe. One-way ANOVA, Students t and Chi-square tests were used for statistical analysis, considering p<0.05 significant.* **Results:** *trauma mechanism was classified by group for 3639 cases, comprising 337 (9.3%) AUTO, 855 (23.5%) PED, 924 (25.4%) MOTO, 455 (12.5%) FALL, 424 (11.7%) ASSA and 644 (17.7%) FSL. There was significant difference among groups when comparing the Revised Trauma Score (RTS), the Injury Severity Score (ISS) and the Abbreviated Injury Scale (AIS) of the head, thorax, abdomen and extremities (p<0.001). Severe injuries in the head and in the extremities were more frequent in PED patients (p<0.001). Severe injuries to the chest were more frequent in AUTO (p<0.001). Abdominal injuries were less frequent in FSL (p=0.004). Complex fractures of the pelvis and spine were more frequent in FALL (p<0.001). Lethality was greater in PED, followed by FALL and AUTO (p<0.001).* **Conclusion:** *trauma mechanism analysis predicted frequency and severity of injuries in blunt trauma patients.*

Keywords: *External Causes. Fractures, Bone. Multiple Trauma. Wounds and Injuries.*

INTRODUCTION

We can understand trauma as a disease that involves the exchange of energy between the environment and the body, resulting in injuries that affect different systems and organs. It is estimated that more than five million people worldwide annually die from this problem[1], leading to more deaths than HIV/AIDS, tuberculosis, malaria and maternal conditions combined[2,3]. For each death, it is believed that there are dozens of hospitalizations, hundreds of consultations in emergency services and thousands of medical consultations[1]. The cost of this disease is incalculable, both for the loss of human lives as well as for the social, economic and cultural aspects involved.

The International Code of Diseases (ICD-10) includes these cases in Chapter XX as "external causes"[4]. This classification is extremely specific, describing details of the various types of accidents and violence. However, there are a large number of codes, which can make the analysis of trauma mechanisms extremely complicated in daily practice. We must also emphasize that this classification takes into account the "intentionality" of trauma, which is often difficult to establish in the first moment of care.

The relationship between the trauma mechanism and the different types of internal injuries is known[5-7]. Several studies have evaluated specific characteristics, even in a prehospital environment, that lead us to observe it[8,9]. The analysis of the trauma mechanism is very important for all professionals responsible for these cases, and is already considered in the initial care standardized by the Advanced Trauma Life Support course[10]. It is therefore a variable that guides decisions regarding the screening and monitoring of patients at higher risk[11].

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In daily practice, we recognize a simplified classification of mechanisms, involving automobile accidents, falls and physical assaults[12]. In previous studies, we observed that some lesions are more frequent in specific mechanisms. The victims of falls of the same level present a higher frequency of cranio-encephalic lesions in comparison with the other mechanisms[13]. Spinal cord lesions and pelvic fractures are characteristic of victims of falls from height[14]. Motorcyclists especially show fractures in the lower limbs, mainly exposed ones[15].

We did not find in the available literature a comparison between all mechanisms of trauma among each other, regarding the frequency and severity of the lesions. This information can aid in the screening, diagnostic evaluation and treatment of certain cases. Our hypothesis is that there is a difference between mechanisms when comparing the frequency and severity of injuries. The objective of this study is to compare the different mechanisms of closed trauma, evaluating the frequency and their severity of injuries in different body segments.

METHODS

In the Emergency Service of the Brotherhood of the São Paulo Holy Home of Mercy (ISCMSP), we carried out a prospective information collection of all trauma patients admitted to the emergency room from 2008 to 2010, with the approval of the Ethics Committee number 37690314.5.0000.5479, with Objective of forming a trauma registry for quality control of care[16,17]. Data were initially collected by surgery residents at patients' admission and subsequently by service assistants during follow-up, until discharge. The information was stored in the Access 2007® software.

We performed a retrospective analysis of the information contained in this registry, including the data of victims of closed trauma aged 13 years and older admitted between 2008 and 2009. We collected information about the mechanism of trauma, vital signs at admission, complementary examinations performed, lesions diagnosed, as well as their severity and treatment.

The severity stratification was performed through trauma indices: Glasgow Coma Scale (GCS), Revised Trauma Score (RTS), Abbreviated Injury Scale (AIS), Injury Severity Score (ISS) and Trauma-Injury Severity score (TRISS). The Glasgow Coma Scale (GCS) measures the patient's level of consciousness using ocular opening parameters, verbal response and motor response, ranging from 3 to 15[18]. The Revised Trauma Score (RTS) is a physiological index that uses the parameters systolic arterial pressure, respiratory rate and Glasgow coma scale, ranging from 0 to 7.8408[19]. The Abbreviated Injury Scale (AIS) is a severity scale of organic lesions published by the Association for the Advancement of Automotive Medicine[20]. According to this classification, each organ has lesions grouped in increasing severities, ranging from 1 to 6. Lesions AIS = 1 are defined as "minor", AIS = 2, as "moderate", AIS = 3, as "Severe ", AIS = 4, as "very severe", AIS = 5, as "critical" and AIS = 6, are lethal. Using this scale, polytraumatized patients can be defined by the presence of lesions with AIS greater than or equal to 3 in at least two body regions[21-24]. The Injury Severity Score (ISS) is an anatomical index based on the AIS organic lesions scale and is one of the most frequent ways of assessing severity in trauma victims[25]. The lesions are grouped into six segments: head and neck, face, chest, abdomen, extremities and pelvis, and external. The most severe lesions of the three most severely affected segments are selected, the sum of their squares being the ISS value[26]. TRISS is an index that allows the calculation of survival probability based on the variables trauma mechanism, age, RTS and ISS[27].

In this study, we separated the victims of closed trauma into six groups, according to the trauma mechanism: AUTO group: occupants of four-wheel vehicles involved in traffic accident; PED Group: run-over pedestrians; MOTO Group: motorcyclists who are victims of traffic accidents; FALL Group: victims of fall from height; ASLT Group: victims of assault with blunt instruments; FSL Group: victims of fall on the same level

We compared the groups regarding the frequency of injuries and severity of trauma in different body segments, values of physiological (RTS)

Table 1. *Comparison of numerical variables between groups, presented as mean (standard deviation).*

	AUTO	PED	MOTO	FALL	ASLT	FSL	p
Age	35.3 (14.5)	41.9 (18.0)	28.9 (8.5)	41.7 (17.0)	35.2 (12.8)	53.2 (20.5)	< 0.001
SBP	127.4 (24.8)	128.1 (26.9)	127.0 (17.1)	128.7 (26.0)	125.9 (15.5)	133.9 (21.3)	< 0.001
HR	82.6 (15.6)	84.2 (14.7)	82.0 (12.4)	83.2 (14.6)	84.3 (13.7)	81.4 (11.7)	< 0.001
GCS	14.3 (2.2)	14.0 (2.4)	14.5 (1.8)	14.1 (2.3)	14.0 (1.9)	14.3 (1.5)	< 0.001
AIS Head	0.4 (0.8)	0.8 (1.3)	0.3 (0.9)	0.6 (1.1)	1.0 (1.0)	0.0 (0.9)	< 0.001
AIS Thor	0.2 (0.8)	0.2 (0.9)	0.1 (0.6)	0.2 (0.7)	0.0 (0.4)	0.0 (0.2)	< 0.001
AIS Abd	0.1 (0.6)	0.1 (0.6)	0.1 (0.6)	0.1 (0.6)	0.0 (0.5)	0.0 (0.5)	< 0.001
AIS Ext	0.9 (0.1)	1.3 (1.3)	1.5 (1.2)	1.2 (1.4)	0.4 (0.6)	0.4 (0.7)	< 0.001
RTS	4.4 (8.1)	7.1 (10.2)	5.5 (8.3)	6.3 (9.4)	3.5 (5.4)	2.8 (4.2)	< 0.001
ISS	7.76 (0.4)	7.68 (0.7)	7.76 (0.5)	7.67 (0.7)	7.72 (0.5)	7.77 (0.3)	0.004
TRISS	0.98 (0.5)	0.96 (0.1)	0.98 (0.1)	0.95 (0.1)	0.99 (0.1)	0.97 (0.1)	< 0.001

SBP: systolic blood pressure; HR: heart rate; GCS: Glasgow coma scale; AIS: Abbreviated Injury Scale; RTS: Revised Trauma Score; ISS: Injury Severity Score.

and anatomical (AIS and ISS) trauma indices and probability of survival (TRISS), as well as performed procedures and deaths.

We performed the statistical analysis with the SPSS 21.0 software. For the comparison of the qualitative variables, we used the Chi-Square test. For the comparison of the numerical variables, we used the analysis of variance ANOVA. For both variables, we considered $p<0.05$ as significant.

RESULTS

The mechanism of trauma was described in 3,639 cases, with 337 (9.3%) AUTO, 855 (23.5%) PED, 924 (25.4%) MOTO, 455 (12.5%) FALL, 424 (7%) ASLT and 644 (17.7%) FSL. The mean age, systolic blood pressure and Glasgow coma scale, as well as the AIS of the different body segments and other trauma indices are described in table 1. The mean age was significantly higher in the FSL group. We observed significant differences in the means of vital signs and the trauma indices at admission between the groups. The mean ± standard deviations for RTS were 7.76±0.42 (AUTO); 7.68±0.76 (PED); 7.76±0.51 (MOTO); 7.67±0.69 (FALL); 7.72±0.51 (ASLT); 7.77±0.34 (FSL) (p=0.004). In the evaluation of the ISS anatomical index, we observed the following means ± standard deviations: 4.37±8.14 (AUTO); 7.09±10.22 (PED); 5.53±8.30 (MOTO); 6.27±9.45 (FALL); 3.52±5.40 (ASLT); 2.78±4.27 (FSL) (p<0.001) (Figure 1).

There was a significant difference in the comparison of the means of the AIS anatomical index in the head segment: 0.45±0.87 (AUTO); 0.80±1.30 (PED); 0.31±0.90 (MOTO); 0.67±1.20 (FALL); 1.07±1.06 (ASLT); 0.93±0.96 (FSL) (p< 0.001) (Figure 2). The anatomical trauma index was significantly different between groups also in the thoracic segment: 0.23±0.86 (AUTO); 0.21±0.80 (PED); 0.14±0.64 (MOTO); 0.22±0.76 (FALL); 0.08±0.45 (ASLT); 0.02±0.25 (FSL) (p< 0.001). The mean AIS for the abdominal segment were as follows: 0.11±0.60 (AUTO); 0.14±0.69 (PED);

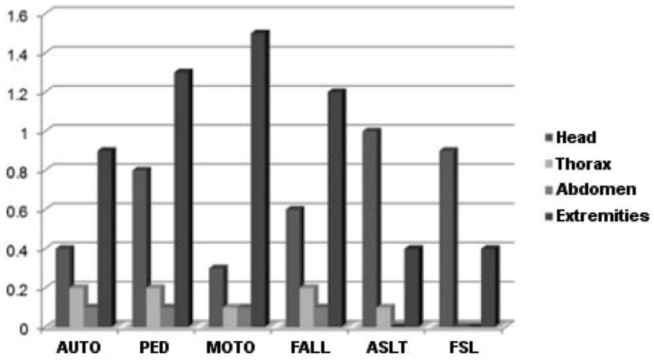

Figure 1. *Comparison of AIS means between groups.*

0.12±0.67 (MOTO); 0.11±0.63 (FALL); 0.09±0.56 (ASLT); 0.01±0.16 (FSL) (p< 0.001). As for the extremities, we also observed a significant difference between groups: 0.94±1.13 (AUTO); 1.35±1.32 (PED); 1.49±1.21 (MOTO); 1.23±1.37 (FALL); 0.41±0.67 (ASLT); 0.45±0.78 (FSL) (p<0.001).

The comparison of frequency of the different lesions between groups is shown in table 2 and figure 3. Severe lesions in the head segment were more frequent in PED victims, followed by ASLT and FALL (p<0.001). Severe lesions in the thoracic segment were more frequent in AUTO, followed by FALL and PED (p<0.001). Severe lesions in the abdominal segment were less frequent in FSL (p=0.004). Severe extremities' lesions were more frequent in PED victims, followed by MOTO and FALL (p<0.001). Complex pelvic fractures were more frequent in FALL, followed by PED (p<0.001). Spinal cord injuries were more frequent in FALL victims (p<0.001). Lethality was higher in PED victims, followed by FALL and AUTO (p<0.001).

Table 3 summarizes the results, grouping the main injured segments for each trauma mechanism.

DISCUSSION

The data from this study demonstrate that the analysis of the trauma mechanism allows inferring the possible injuries to investigate in victims of closed trauma. That is, the professional can better consider the chances of the different injuries occurring in a certain scenario. One can use this information in field screening, prioritization of in-hospital care and complementary examinations. This

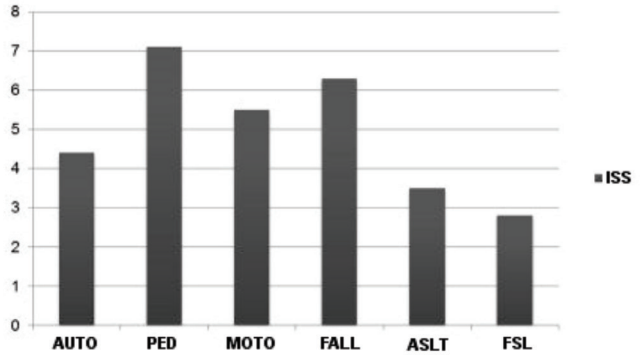

Figure 2. *Comparison of ISS means between groups.*

becomes extremely important, given the plethora of emergency services and the need to reduce the number of diagnostic tests with negative results, as well as the need for reduction and selective use of semi-intensive and intensive care units.

Another point we should consider is that, in trauma victims, many severe injuries may not have clinical repercussions at first. Abdominal injuries can occur without signs or symptoms, as well as extradural hematomas, vascular, airway and digestive tract injuries, among others. Objective evaluation by imaging methods becomes mandatory in cases where these are more frequent. The information in this study allows establishing a link between the mechanism and the chance of injury, even if they do not present clinical repercussions at admission.

To define the severity of each lesion, several indices and scales may be used[28]. In this study, we chose to use the ones most frequently described in the literature. There are criticisms of the non-rational use of these indices, since none of them can be applied blindly in all patients. To correctly estimate the severity of trauma victims, it is necessary to individualize the analysis of each lesion, to stratify its severity, and finally to combine them, returning to the analysis of the patient as a whole[29]. Our data demonstrate a significant difference when comparison the trauma indices between the different mechanisms. That is, regardless of the criticism regarding them, we observed that the severity of the trauma is different between groups.

Apparently, the mechanisms with higher frequency and severity of injuries were run-over and falls from height (Table 3). Both have in common the fact that the energy exchange is directly between the body and the aggressor agent, corroborating with the greater lethality in these groups. We observed several specific characteristics attributed to different mechanisms of trauma (Table 3). The occupants of four-wheel motor vehicles (AUTO) presented higher frequency and severity of thoracic segment injuries, probably associated with deceleration and direct impact on the thorax. Run-over victims had serious injuries in several body segments, mainly cranio-encephalic trauma. Motorcyclists had higher frequency and severity of lesions at the extremities

Table 2. *Comparison of qualitative variables between groups (in%).*

Variable	AUTO	PED	MOTO	FALL	ASLT	FSL	P
Male gender	68.8	67.7	87.9	78.2	85.5	66.6	< 0.001
SBP < 90mmHg	3.6	4.0	1.5	3.1	1.2	0.3	< 0.001
Head AIS ≥ 3	5.0	12.6	4.8	8.8	10.2	8.1	< 0.001
Thorax AIS ≥ 3	5.6	4.7	3.6	4.8	0.9	0.6	< 0.001
Abdomen AIS ≥ 3	3.0	3.2	2.7	2.6	2.1	0.2	0.004
Extremities AIS ≥ 3	11.6	21.6	20.6	19.3	2.1	4.5	< 0.001
Epidural Hematoma	0.3	2.9	0.6	2.6	2.4	1.7	< 0.001
Subdural Hematoma	0.6	3.0	0.9	2.4	1.2	2.2	0.004
Subarachnoid hemorrhage	0.9	3.5	0.9	2.4	0.9	2.3	0.001
Cerebral contusion	1.8	4.8	1.2	4.2	2.1	4.2	< 0.001
Diffuse axonal injury	1.8	1.4	1.6	0.2	0.2	0	0.001
Fracture of skull cap	0.9	2.7	1.3	2.2	4.5	1.2	0.001
Fractures of skull base	1.2	2.0	1.2	2.0	3.8	1.7	0038
Fractures of the face	3.6	4.9	3.8	3.7	12.5	3.9	< 0.001
Spinal cord injury	0.9	1.4	1.0	4.4	0.2	0.1	< 0.001
Pneumothorax	3.6	2.3	1.9	2.4	0.2	0.1	< 0.001
Hemothorax	2.1	2.5	1.8	2.9	0.7	0.5	0.011
Rib fractures	6.8	5.1	2.6	4.8	2.1	0.5	< 0.001
Flail chest	2.7	2.2	0.9	0.7	0.2	0.0	< 0.001
Pulmonary contusion	3.9	2.9	1.7	2.2	0.2	0.0	< 0.001
Liver	2.1	1.5	1.4	1.5	0.5	0.1	0.016
Spleen	0.6	1.6	1.6	1.5	0.7	0.2	0044
Complex pelvic fractures	0.1	0.9	0.1	2.0	0	0	< 0.001
Open fractures	4.2	5.7	7.4	4.0	0.2	0.1	< 0.001
Death	2.4	4.4	0.9	3.1	1.7	0.9	< 0.001

SBP: systolic blood pressure; AIS: Abbreviated Injury Scale.

and lower frequency and severity of lesions in the cephalic segment. Fall victims had a higher frequency of pelvic fractures and spinal cord trauma. Those who suffered physical assaults had the cephalic segment more affected than the others did, with a higher incidence of fractures in this region. The victims of falls of the same level were older and had greater severity of intracranial lesions.

There are limitations one must observe when interpreting our data. We use a "generalization" of trauma mechanisms. For example, not all tramplings are similar. Some victims may have a direct impact on

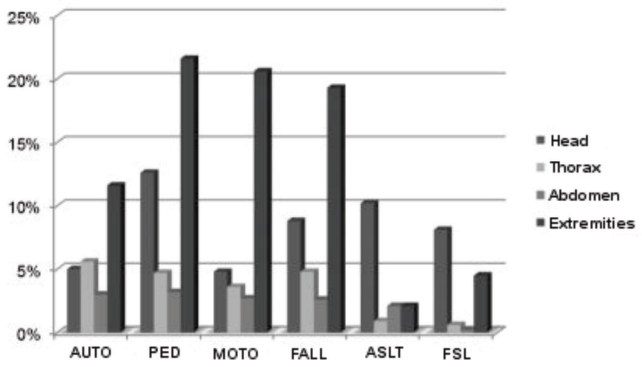

Figure 3. *Frequency of lesions with AIS>2.*

Table 3. *Presence of severe injuries (AIS 2 >) in different body segments, grouped by the mechanism of trauma.*

	Head	Chest	Abdomen	Extremities
AUTO		X	X	
PED	X	X	X	X
MOTO			X	X
FALL	X	X		X
ASLT	X			
FSL				

For each column, which represents a body segment, we indicate with an X the three trauma mechanisms with the highest frequencies of severe injuries. This way we can identify the body segments with severe injuries more often observed for each mechanism.

the lower limb and others on the trunk or cephalic segment. However, there is a well-defined goal in this tactic. This "generalization" allows that the characteristics common to certain trauma mechanisms be recognized, but at no time does it exclude the possibility of uncharacteristic injuries to a certain group.

Another interesting point is the low frequency of lesions in this sample. This is due to the general care of an "open door" hospital. Perhaps these numbers correspond well to the reality of these types of services. One might question how a hospital with a type III trauma center (supposedly prepared to treat cases that are more complex) ends up treating so many patients with mild injuries. This is due to characteristics of the local health system, where we observe a significant supertriage. Ideally, each trauma victim is assessed according to severity already on the scene, by criteria such as ISS greater than 15, need for intensive treatment and / or non-orthopedic surgery. These cases, considered severe, are then referred to the level 1 trauma center (of greater complexity in the American system), reducing supertriage and, consequently, the overcrowding of hospitals and the costs of care[9].

The frequency of trauma mechanisms depends on the region in which they are analyzed. It is also believed that there is influence of the environment where the trauma occurred, whether civil or military, on the genesis of the lesions[30]. Trauma is a socioeconomic-cultural disease. The analysis of our reality exposes the routine of an urban center, serving the majority of victims of closed trauma. The frequency of accidents involving motorcyclists, whose injuries occur mainly in the lower limbs, demand long time of hospitalization, treatment and social security dependence. It is necessary, on the part of the authorities, to take measures to control this type of event. Preventive measures should also be directed to other mechanisms.

In our study, we did not specifically evaluate trauma in cyclists because, at the time of data collection, the number of patients with this mechanism was not yet significant. We chose to exclude victims of trauma with combined mechanisms or that could not be clearly allocated in any group so that the analysis was free of overlap. Another open point in our study was the impossibility of acquiring information about the protective equipment used by the victims at the time of the accident, such as helmets, vests, boots, etc. Perhaps this information would contribute even more to the characterization of groups.

The data from this study can assist teams in making decisions both at the scene and at the hospital. The information from the prehospital care group and the traumatized individual can provide decisive data for the correct choice between the various diagnostic and therapeutic options in trauma victims. They can also assist in patient screening, resource optimization in emergency services, and early diagnosis of potentially fatal occult injuries.

We conclude that the frequency and severity of traumatic injuries may be related to the mechanism of trauma.

R E S U M O

Objetivo: analisar a correlação do mecanismo de trauma com a frequência e a gravidade das lesões. **Métodos:** análise retrospectiva das informações do registro de trauma em período de 15 meses. O mecanismo de trauma foi classificado em seis tipos: ocupantes de veículo de quadro rodas envolvidos em acidente de tráfego (AUTO), pedestres vítimas de atropelamento (ATRO), motociclistas vítimas de acidentes de tráfego (MOTO), vítimas de quedas de altura (QUED), vítimas de agressão física com instrumentos contundentes (AGRE) e vítimas de queda do mesmo nível (QMN). **Resultados:** o mecanismo de trauma foi classificado em 3639 casos, sendo 337 (9,3%) AUTO, 855 (23,5%) ATRO, 924 (25,4%) MOTO, 455 (12,5%) QUED, 424 (11,7%) AGRE e 644 (17,7%) QMN. Houve diferença significativa na comparação entre os grupos das médias dos índices do *Revised Trauma Score* (RTS), do *Injury Severity Score* (ISS) e da *Abbreviated Injury Scale* (AIS) do segmento cefálico, torácico, abdominal e extremidades (p<0,05). Lesões graves em segmento cefálico foram mais frequentes nas vítimas de ATRO, seguidos de AGRE e QUED (p<0,001). Lesões graves em tórax foram mais frequentes em AUTO, seguidos de QUED e ATRO (p<0,001). As lesões abdominais foram menos frequentes nas vítimas de QMN (p=0,004). Lesões graves em extremidades foram mais frequentes em ATRO, seguidos de MOTO e QUED (p<0,001). **Conclusão:** com a análise do mecanismo de trauma é possível prever a frequência e a gravidade das lesões em vítimas de trauma fechado.

Descritores: Causas Externas. Ferimentos e Lesões. Fraturas Ósseas. Traumatismo Múltiplo.

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