

Anthropometric characteristics and traffic accident circumstances of patients with isolated whiplash injury in University Clinical Hospital Mostar

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ABSTRACT

Aim To investigate anthropometric characteristics and traffic accident circumstances of subjects with isolated whiplash injury.

Methods This cross sectional study involved 75 subjects from traffic accidents with isolated whiplash injury classified by Quebec Task Force (QTF). Anthropometric data were collected as well as claims about circumstances of traffic accidents.

Results Distribution of 1st (28; 37.3%), 2nd (25; 33.3%) and 3rd (22; 29.3%) grade of whiplash injury was almost equal. Females had smaller anthropometric measurements than males; neck circumference was the most significant difference between males and females in the context of whiplash injury. The most frequent collision mechanism was impact to front (26; 34.7%) or to rear end (26; 34.7%) of a small passenger's car. Assertions of participants were that their car damage was significant (37; 49.2%) or total (24; 32%). A total of 38 (50.7%) participants claimed that they were not wearing safety belt and 52 (69.3%) did not find themselves responsible for accident.

Conclusion Driving habits of our participants facilitate incidence of whiplash injuries, especially in vulnerable groups such as women and elderly.

Key words: automobile driver examination, gender identity, claims review

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INTRODUCTION

Whiplash injury is a strain damage of neck and related structures after sudden and excessive flexion-extension of the cervical spine. From that time, it was primarily associated to traffic accidents, although it can occur in any situation if the mechanism of injury is satisfied (1). Orthopaedic surgeon Crowe 1928 was first one who described, named and explained mechanism and some implications of whiplash injury (2). Davis in 1945 researched problems about “obscure” signs and symptoms related with appropriate diagnosis of whiplash injury, and proposed careful taking of anamnestic data about circumstances of injury (3). Gay and Abbot from 1953 noticed increased frequency of this kind of injury as well as its connection with forensic litigation (4).

Epidemiologic characteristics of whiplash injury vary greatly in different parts of the world, even in different parts of the same country (5). It is assumed that a significant number of factors influence a patient’s decision to report the injury and the problems are also often inconsistent studies on this matter (5-8).

Whiplash injury appears mostly after rear end collision in passenger’s cars (1). Nevertheless, in everyday practice, injuries after unidirectional force are rare; more often are result of combined flexion-extension, rotation, shearing etc. (9). The simplest model of whiplash injury, and also the most common one is an impact of a moving vehicle to the rear end of a stationary vehicle (9-11). During the collision, the body of a driver or passenger has primary and secondary movement, and highest range of motion is in the neck. That movement is the result of inertia after vehicle collision and transfer of force dependent on mass and acceleration, which results in a lunge like a whiplash (2,9,10,11) (Figure 1). The lunge is various and

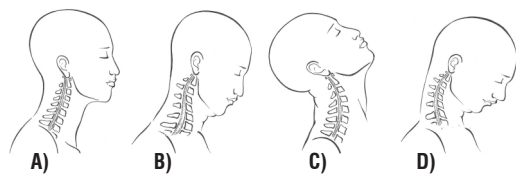


Figure 1. Illustration of mechanism of whiplash injury: A) physiologic cervical spine position B) S-shape of cervical spine during impact C) hyperextension of cervical spine D) hyperflexion of cervical spine (Perić I, 2017)

depends of acceleration change highlighted as a delta V (ΔV). Minimal ΔV has to be 8 km/hour for whiplash injury to occur, and severity of whiplash injury correlates with increasing ΔV (12). If the driver is wearing a seat belt, this movement would be stopped by it, but if not, than the body of the driver will decelerate in collision with car cabin parts, such as wheel, windshield or command board. Constructing innovative sliding seats tries to reduce hazard during car accidents (13). Very soon after injury, acute symptoms called whiplash associated disorders (WAD) occur (1). Possibility of progression of acute symptoms to chronic impairment is still a matter of scientific dispute (1,14,15).

Most famous multidisciplinary scientific research of whiplash injury is the one by Quebec Task Force (QTF). They made very useful QTF classification for WAD which differentiates 5 grades of whiplash injury (from 0 to 4) (16). It is proven that females, mostly because of gracile constitution, more often have whiplash injury after car accidents as well as higher QTF grade and prolonged recovery compared to males (17).

Although, whiplash injury is quite common, there are no specific studies from our country about epidemiology of this phenomenon. From neighbourhood countries, only the Republic of Croatia has conducted a few studies about the whiplash injury, and one of them is about their epidemiologic, clinical and medicolegal characteristics (18). We decided to examine some fundamental characteristics of patients with whiplash injury and give basics for future researches of this everyday neck pathology.

The aim of this study was to investigate circumstances of traffic accidents (according to patients’ assertions) and anthropometric characteristics of patients with isolated whiplash injury, and relationship with a grade of whiplash injury (according to QTF classification).

EXAMINEES AND METHODS

Study design and examinees

This cross sectional study involved 75 participants with whiplash injury as a consequence of car accidents who were admitted to the Emergency Centre of University Clinical Hospital (UCH) Mostar within six hours after the accident during the period 1 September 2013 to 1 January

2016. After complete examination of patients, their whiplash injury was graded according to the QTF (15), which differentiates 5 grades of whiplash injury (from 0 to 4). This research involved only patients with isolated whiplash injury without additional lesions. Patients with 0 grade of whiplash injury did not report to the doctor, while patients with 4th grade did not have isolated whiplash injury which excluded them from this study, leaving only patients with grades 1-3 suitable for the investigation.

Exclusion criteria were concomitant injuries, polytrauma, neck contusion, severe degenerative change of cervical spine, osteodegenerative and rheumatoid illness of locomotor system, previous injuries of locomotor system, neuromuscular degenerative diseases, conditions after stroke, use of drugs which affects muscles or nerves, previous operations on cervical spine, older than 60 years, younger than 18 years.

The research was conducted in accordance with the Declaration of Helsinki and principles of high quality clinical practice. Medical Ethic Committee of the UCH Mostar by its decree of 6 February 2013, reference number 767/13, approved this research.

All subjects signed an informed consent after receiving a detailed oral and written description of the research prior to their involvement in the research. The research was conducted in accordance with the Declaration of Helsinki and principles of high quality clinical practice, with an approval of the Medical Ethics Committee of the UCH Mostar.

Methods

Every (potential) participant underwent a diagnostic protocol for the confirmation of the whiplash injury. Anamnestic data were taken (name, last name, age, and gender), details about the car accident, about current and previous ailments.

Physical examination included inspection and palpation of head and neck, examination of neck movement range, assessment of muscle strength of upper limbs, and neurological assessment.

Radiologic examination followed after the clinical examination, and it included anteroposterior and lateral X-ray of cervical spine, interpreted by a radiologist. Emergency CT scan was performed

in case of suspicion of spinal injury (patients with confirmed spinal injury were excluded from the study). During the physical examination, anthropometric data were taken: body weight, body height, body mass index (BMI), and neck circumference. Body weight and height were taken while participants were wearing only underwear, in a standing position, without footwear using a multipurpose beam scale SECA 223 (Hamburg/Germany). Both measurements were performed three times and median value was taken and expressed in kilograms (kg) and centimetres (cm), respectively. The BMI was calculated as a ratio of body weight and square of body height ($BMI=kg/m^2$). Neck circumference was taken with a tape measure positioned under laryngeal prominence and the result was noticed in centimetres.

Statistical analysis

Data collected from 75 participants with whiplash injury were analysed with descriptive, parametric and non-parametric statistical methods depending of preconditions: χ^2 test, Student t test, ANOVA. During descriptive interpretation, continuous variables were presented over arithmetic mean and standard deviation, but categorical variables were presented over frequencies and percentages. The level of probability of $p<0.05$ was taken as significant.

RESULTS

In this study males were injured more often compared to females, but without statistical significance (44/58.7% and 31/41.3%, respectively) ($p>0.05$). There was no significant difference according age between genders. Differences were noticed in all analysed anthropometric measurements ($p<0.05$): males were in average higher, more weighed, had bigger neck circumference, and had higher BMI (Table 1).

Table 1. Anthropometric characteristics of the sample according to gender

Variable	Males	Females	p
No (%)	44 (58.7)	31 (41.3)	0.133
Age (X±SD)	33.78 ±11.68	35.06 ±10.25	0.488
Height (X±SD)	185.66 ±6.95	170 ±5.78	0.000
Weight (X±SD)	92 ±18.33	68 ±10.05	0.000
BMI (X±SD)	26.57 ±5.15	23.53 ±3.37	0.000
Neck circumference (X±SD)	41.59 ±3.45	33.94 ±2.18	0.000

In this sample the number of patients with the 1st grade whiplash injury was 28 (37.3%), with the 2nd grade 25 (33.3%), with the 3rd grade 22 (29.3%).

There was no statistically significant difference in distribution according to the grade of whiplash injury between genders ($p>0.05$) (Table 2).

Table 2. Distribution of gender by a degree of whiplash injury according to the Quebec Task Force (QTF) classification

QTF grade	No (%) of patients		
	Males	Females	Total
1 st	17 (38.6)	11 (35.5)	28 (37.3)
2 nd	15 (34.1)	10 (32.3)	25 (33.3)
3 rd	12 (27.3)	10 (32.3)	22 (29.3)

Patients with diagnosed whiplash injury were significantly frequent drivers of vehicles, in 61 (81.3%) cases ($p>0.00$). There was almost equal number of patients who reported that they used the seat belt during the car accident (38; 50.7%) and who did not use the seat belt (37; 49.3%) ($p=0.908$). Drivers used seat belts in 34 (45.3%) cases, and in 27 (35.9%) cases seat belts were not used; passengers in front seats used the seat belt in 4 (5.4%) cases and in 6 (7.9%) cases they did not use it; and finally, passengers in rear end in 4 (5.3%) cases never used seat belts.

Majority of patients did not consider themselves responsible for accident, 52 (69.3%) ($p=0.000$).

Table 3. Circumstances of the injury according to patients' reports with regard to the grade

Variable	Grade of whiplash injury (Quebec Task Force classification)			Total	p
	1st	2nd	3rd		
Position in vehicle N (%)					0.208
Driver	22 (36.1)	23 (37.7)	16 (26.2)	61 (81.3)	
Passenger front	5 (5.0)	2 (2.0)	3 (3.0)	10 (13.3)	
Passenger rear end	1 (2.5)	0 (0)	3 (7.5)	4 (5.3)	
Seat belt use N (%)					0.345
Yes	13 (34.2)	11 (28.9)	14 (36.8)	38 (50.7)	
No	15 (40.5)	14 (37.8)	8 (21.6)	37 (49.3)	
Fault N (%)					0.284
Others	18 (34.6)	17 (32.7)	17 (32.7)	52 (69.3)	
Owens	9 (56.2)	5 (31.2)	2 (12.59)	16 (21.3)	
Unfortunate circumstance	1 (14.3)	3 (42.9)	3 (42.9)	7 (9.3)	
Type of collision N (%)					0.889
Rear end	9 (34.6)	7 (26.9)	10 (38.5)	26 (34.7)	
Frontal	9 (34.6)	10 (38.5)	7 (26.9)	26 (34.7)	
Combined	3 (47.5)	3 (37.5)	2 (25)	8 (10.7)	
Side	7 (46.7)	5 (33.3)	3 (20)	15 (20)	
Type of vehicle N (%)					0.649
Passengers	26 (37.7)	23 (33.3)	20 (29)	69 (92)	
Vans	2 (40)	1 (20)	2 (40)	5 (6.7)	
Jeep	0 (0)	1 (100)	0 (0)	1 (1.3)	
Assessment of damage N (%)					0.916
Total	9 (37.5)	7 (29.2)	8 (33.3)	24 (32)	
Major	14 (37.8)	12 (32.4)	11 (29.7)	37 (49.2)	
Minor	5 (35.7)	6 (42.9)	3 (21.4)	14 (18.7)	
Age of vehicle (X±SD)					0.672
	12.46±8.23	13.92±7.37	15.23±7.78	13.76±7.8	

With regard to the type of collision, 26 (34.7%) were reported each in front and rear end of the car ($p=0.006$).

Majority of patients were injured in passenger cars (69; 92%), while the minority were injured in motor vehicles such as vans (five; 6.7%) or SUV (Jeep) (one; 1.3%) ($p=0.000$). Almost half of patients claimed that the damage of their own car was greater compared to other involved cars, 37 (49.2%); 24 (32%) patients evaluated damage of their own car as „total“, and 14 (18.7%) considered their car damage as minor ($p=0.005$).

Analysing specific circumstances (car position, use of seat belt, type of collision etc.) of occurrence of whiplash injury, it was not found that either of them was related with the grade of injury (Table 3) ($p>0.05$).

The examination of anthropometric measurements of the patients was not related to the grade of whiplash injury with an exception of (mean) age of patients which was higher in those patients with higher grade of whiplash injury (Table 4) ($p<0.05$).

Table 4. Anthropometric characteristics of patients with regard to the grade of whiplash injury

Grade of whiplash injury (Quebec Task Force classification)	Age (years)	Height (cm)	Weight (kg)	BMI (kg/m ²)	Neck circumference (cm)
1 st	Mean 30.43	180.21	81.6	24.94	38.28
	Std. Deviation 10.53	9.65	18.78	4.51	4.95
2 nd	Mean 33.64	179.5	83.4	25.74	38.16
	Std. Deviation 11.18	9.11	21.51	5.73	4.52
3 rd	Mean 40.86	176.54	81	25.67	38.57
	Std. Deviation 9.31	12.27	18.79	3.97	5.06
P	0.003	0.434	0.908	0.802	0.958

BMI, body mass index;

DISCUSSION

This study has shown a small predomination of males in traffic accidents with whiplash injuries, although many prior studies showed that majority were females and they were more severely injured (19,20). The difference of gender distribution was not statistically significant, probably because of exclusion of patients with concomitant injuries that affect mostly women (19). Besides the greater number of females with whiplash injury in general population, their slower recovery was also noticed (19-21).

In this sample, the patients with 1st, 2nd and 3rd grade of whiplash injury according to QTF classification are equally distributed, which is not re-

representative for the patients with whiplash injury (18,19). The cause of such equal distribution was also probably due to the exclusion criteria during the selection of participants, e. g. concomitant injuries, which mostly appeared with higher grades of whiplash injury (18). This observation has no firm foothold in available literature, partly because we did not find any research about prevalence of concomitant injuries in the patients with whiplash injury and there was low prevalence of whiplash injury in severely harmed patients (22-24). Other studies cite more natural and logic distribution, where the most frequently injured are those with QTF 1st, and afterwards those with 2nd and 3th grade. Also, we should keep in mind QTF 0 and QTF 4th grade patients who were excluded from this and most other studies (25,26).

Of all anthropometric parameters, we accentuated neck circumference as most important in circumstances when whiplash injury occurs, and we proved that women had smaller neck circumference. In one research, which studied gender determinate anthropometric differences in the context of whiplash injury, results were very similar to ours: average measurements of neck circumference in males were 39.4 ± 2.2 cm and in females were 33.1 ± 2.0 cm (27). Other anthropometric measurements from these studies could not be compared because the goal of compared study was to nullify anthropometric differences between males and females and to analyse the measurements of neck and spine, so the males had smaller height and weight and also were about 10 years younger (27). It is interesting to point out that authors have found that even though the measurements of head were not significantly different between genders, female neck has more trouble bearing weight of the head during the whiplash injury in comparison to males. According to them, female neck is not only "smaller", but is also completely different from male neck with clearly expressed gender dimorphism (27). Gentle constitution of females, especially neck, is a predisposing factor for frequent and severe damage during different mechanisms of injuries, including whiplash injury (27,28).

In this study, a representative participant was a driver of a passenger's car, who did not consider himself responsible for the accident and estimated damage on his own vehicle as the major one.

Rear end collision which was usually found typical for whiplash injury occurrence (9), was not the most frequent neither the only circumstance of traffic accident and it was equally frequent as the front collision. For example, a Swedish study with 3.704 participants with whiplash injury and similar including parameters with regard to the type of impact and position in the vehicle had results comparable to ours. Ultimately, we can conclude that we follow trends of Western countries regarding some of the circumstances of traffic accidents (29).

In this study, seat belt use is very controversial in the context of protection or predisposition for the occurrence of whiplash injury, half of drivers and passengers in the front seat reported that they had used the seat belt, but passengers on the back seat never used it. We have not found a statistically significant difference in the representation of degree of whiplash injury considering the seat belt use, although it should be noted that 14 participants with the 3rd grade injury according to QTF used the seat belt in comparison with eight participants who did not. Similarly, in a study from Bosnia and Herzegovina it was found that the use of seat belts by drivers is quite rare (30). This suggests that usage of the seat belt in our region is very low, especially if we know that it is a legal obligation (29-31). Also, we presumed that the seat belt is probably claimed to be used more often than it actually is. The seat belt definitely protects against serious injuries in traffic accidents, and in the context of whiplash injury, the absence of seat belt use is a proven factor for developing chronic WAD (32).

Regarding the type of the vehicle, whiplash injury mostly occurred in persons in small passenger cars, and rarely in vans or SUVs. In this study, this type of injury was not noticed in other types of vehicles such as buses, trucks or some working machines. Injured persons are more likely to describe damage of their car as major or total. Some of those results are comparable with the British study cited earlier (22). We have also proved that whiplash injuries occur mostly in personal, small cars, partly because this type of vehicle is most widespread in general population, and on the other hand because it is quite small and cannot give protection for passengers as robust vehicles can (22). We did not prove that the

grade of whiplash injury has any connection with a type of vehicle, nor self-assessment of damage. However, we stress that 14 injured patients participated in traffic accidents where damage on their vehicles was self-assessed as minor (without statistical significance). It should be noted that majority of patients were drivers and passengers in the front seats, which can be connected with seats and their role in whiplash injury mechanism during an impact as well as with such a distribution of traffic participants (13). A relationship between the increasing age of patients with whiplash injury and grade of injury according to the QTF classification can be explained with degenerative changes of cervical spine related to aging (33).

In conclusion, driving habits of our participants favours the emergence of traffic accidents. Whi-

plash injury is common neck pathology, and it is predictable that it will affect vulnerable groups. Women and elderly are more vulnerable in traffic accidents than men, especially in conditions where safety procedures were not conducted. Changing driving habits, using of seat belts and safer vehicles could prevent lots of whiplash injuries. A decreasing incidence of whiplash injury would greatly release burden from the health care system as well as insurance companies that pay compensation for bodily injuries.

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Competing interests: None to declare.

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