Pattern of motorcycle-related injuries in Tehran, 1999 to 2000: a study in 6 hospitals

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أنماط الإصابات الناجمة عن حوادث الدراجات النارية في طهران، من عام 1999 إلى عام 2000: دراسة في ستة مستشفيات

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الخلاصة: قام الباحثون بدراسة الإصابات الناجمة عن حوادث الدراجات النارية في طهران، في ما بين 23 آب/أغسطس 1999 و21 أيلول/سبتمبر 2000، وذلك في ستة مستشفيات. وتم الحصول على المعطيات من سجل الرضوح ومن الاستبيانات التي استكملها الأطباء المدربون. وبيَّنت الدراسة أنه من بين المصابين بالرضوح، البالغ عددهم 8500، كان 1332 منهم من راكبي الدراجات النارية، وكانت نسبة المصابين بين الذكور إلى الإناث 1:15. ومن جملة راكبي الدراجات النارية المصابين البالغ عددهم 1332 هؤلاء، كان 1226 يقودون الدراجات وقت الحادث، و75 يركبون على المقعد الخلفي. وكان النمط الأكثر شيوعاً للحوادث هو التصادم مع مركبة أخرى (72.5٪). ولوحظ ارتداء خوذة الرأس في 8.6٪ من الحالات. وقد نجم عن هذه الحوادث 28 وفاة، وكانت إصابة الرأس هي السبب الرئيسي للوفاة. وقد تعرَّض 2.7٪ فقط ممن يرتدون الخوذات أثناء القيادة لإصابات في الرأس، بالمقارنة مع 11.2٪ ممن لا يرتدون الخوذات أثناء القيادة. وتمثَّلت الإصابة العضلية الهيكلية الأكثر شيوعاً في الكسور، وكان كسر عظمة الظنبوب يمثل أكبر نسبة من الإصابات، إذ حدث في 509 حالات (49.8٪).

ABSTRACT We studied motorcycle-related injuries in Tehran from 23 August 1999 to 21 September 2000 in 6 hospitals. Data were obtained from the trauma registry and questionnaires completed by trained physicians. Of a total of 8500 patients with trauma injuries, 1332 were motorcyclists, with a male to female ratio of 15:1. Of these, 1226 patients were driving the motorcycle at the time of the accident and 75 were pillion passengers. Crashes involving another vehicle were the commonest kind of accident (72.5%). Helmet use was noted in only 8.6% of cases. There were 28 fatalities and head injuries were the prominent cause of death. Of those who died, none had been wearing a helmet at time of the crash. Only 2.7% of helmeted riders sustained a head injury, compared with 11.2% of riders without a helmet. The commonest musculoskeletal injury was fracture: tibial fracture with 509 cases (49.8%) comprised the largest proportion.

Caractéristiques des traumatismes dus aux motocycles à Téhéran, 1999-2000 : étude dans six hôpitaux

RÉSUMÉ Nous avons étudié les traumatismes dus aux motocycles à Téhéran du 23 août 1999 au 21 septembre 2000 dans six hôpitaux. Des données ont été obtenues à partir du registre des traumatismes et des questionnaires remplis par des médecins qualifiés. Sur un total de 8500 patients ayant eu des blessures traumatiques, 1332 étaient des motocyclistes, le rapport des sexes masculin/féminin étant de 15:1. Sur ces derniers, 1226 patients conduisaient la motocyclette au moment de l'accident et 75 étaient des passagers à l'arrière. Les collisions qui impliquaient un autre véhicule étaient les formes les plus courantes d'accidents (72,5 %). L'utilisation du casque n'a été constatée que dans 8,6 % des cas. Il y avait 28 victimes et les traumatismes crâniens représentaient la principale cause de décès. Aucune des personnes décédées ne portait de casque au moment de la collision. Seuls 2,7 % des personnes portant un casque ont subi un traumatisme crânien contre 11,2 % des personnes ne portant pas de casque. La fracture était le traumatisme ostéo-articulaire le plus courant : avec 509 cas (49,8 %), la fracture du tibia représentait la plus forte proportion.

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Introduction

Injuries are the most common cause of death among people 1 to 34 years of age, a leading cause of disability and years of life lost, and a major contributor to health care costs [*1*]. Traffic accident injuries represent an important proportion of injury-related morbidity and mortality among young people [*2*]. All over the world, motorcycle collisions account for a considerable rate of morbidity and mortality due to traffic accidents [*3–7*]. It has been observed in previous studies that head and limb (especially lower limb) injuries are very common amongst motorcyclists [*3,6,8*]. Lower extremity injuries, which affect 32% to 80% of injured riders, are the most common outcomes of nonfatal motorcycle crashes [*3,9*]. On the other hand, head injuries are diagnosed in half or more of all deaths to motorcyclists in crashes [*10–12*].

Like many Asian countries, motorcycles are one of the most important forms of transportation in the Islamic Republic of Iran. Over the past few years the number of motorcycles has increased remarkably in Tehran, the capital city. According to data from numerous sources such as newspapers, motorcycle manufacturers, the police, more than 2 million motorcycles are used for transportation in the city. There are no data and previous studies on the incidence and pattern of motorcycle injuries in our country. The purpose of this study therefore was to describe the epidemiology of motorcycle rider injuries during 13 months trauma registration in Tehran.

Methods

The study population was trauma patients admitted to emergency rooms (ERs) of 6 general hospitals in Tehran during a 13-month period (from 23 August 1999 to 21 September 2000). These 6 hospitals receive the greatest load of trauma patients in Tehran and are located in different parts of the city. Data were obtained from the trauma registry which is a registry of all patients who sustained injury within 1 week prior to presentation to ERs and were hospitalized for more than 24 hours. Patients who suffered burns and exposure to toxic substances were excluded since there are specialized referral hospitals for such patients in Tehran. A valid and reliable questionnaire, designed in Sina Trauma and Surgery Research Center (STSRC), was used for the study [*13*]. The questionnaire was completed by trained physicians attending to trauma patients in the ERs and wards.

A motorcycle was defined according to the International Classification of Disease definition (ICD-10), as a two-wheeled motor vehicle with one or two riding saddles and sometimes with a third wheel for the support of a sidecar [*14*]. The study included motorcycles with an engine with capacity of 80–250 cc (motorcycle > 250 cc are not available in the country). Data obtained included demographic information on the patients, prehospital care, medical and operative procedures performed in ERs and wards, Glasgow Coma Scale (GCS) and vital signs at the time of presentation to ERs, Injury Severity Score (ISS), length of hospital and intensive care unit (ICU) stay, outcome and source of reimbursement. The injury and mechanism of accidents were grouped based on ICD-10 [*14*] and statistical analysis was performed using the *SPSS*, version 10.0. $P = 0.05$ was considered as the level of statistical significance.

Results

From 23 August 1999 to 21 September 2000, 8500 trauma patients were admitted

to the ERs in the 6 general hospitals. Motorcycle crashes accounted for 1332 patients (15.7%). Males outnumbered females with a male to female ratio of 15 to 1 ($\chi^2 = 98.55$, $P = 0.001$) (Table 1). The mean age was 28.11 years (range 1 to 75 years); 917 cases (68.8%) were younger than 30 years. Of the motorcycle injury cases, 1226 patients were driving the motorcycle at the time of the accident and 75 were pillion passengers; for 31 patients this was unspecified. Helmet use was infrequent in the studied motorcyclists. Only 115 riders (8.6%) had been wearing a helmet, whereas 1217 (91.4%) were not helmeted. Of the 1226 driving the motorcycle, 110 (9.0%) were wearing a helmet, compared to 5 of 75 (6.7%) who were passengers. Total reported helmet use varied by time of accident; between 16:00 and 19:00 it was 25.2%, while it declined to 4.4% between 23:00 and 07:00. Helmet use among riders was higher in winter (34.8%) and autumn (26.0%) than in spring (16.0%) and summer (23.2%).

Table 1 Characteristics of the injured motorcyclists in Tehran

Characteristic	No. (n = 1332)	%
Age group (years)		
< 20	381	28.6
20–40	773	58.0
> 40	178	13.4
Sex		
Male	1249	93.8
Female	83	6.2
Motorcyclist (n = 1299)[a]		
Rider	1226	94.4
Pillion passenger	75	5.8
Helmet use		
Used	115	8.6
Not used	1217	91.4
Place		
Urban area	158	11.9
Rural area	1174	88.1
Injury severity score[b]		
Mild	833	62.6
Moderate	396	29.7
Severe	103	7.7

[a]For 31 patients, this information was not known.
[b]Injury severity score (mild = 1–7, moderate = 8–11, severe □12).

As regards other variable, 158 patients (11.9%) had had the accident in an urban area whereas 1174 (88.1%) had sustained their injuries in rural areas. The highest percentage (16%) of motorcycle crashes occurred between 17:00 and 19:00. In addition, motorcycle-related injuries were more common during the summer months (32.4%). As regards type of accident, 967 (72.5%) of the patients were injured in motorcycle crashes involving another vehicle (e.g. truck, car, motorcycle); collision with a car was the commonest kind of collision with 860 cases (64.6%). Just over a quarter of patients, 365 (27.4%), suffered injury as a result of a non-collision accident; of these, 70.1 % (256/365) were injured due to overturning of the motorcycle. Twenty-nine (29) of the patients sustained injuries resulting from being trapped by a part of the motorcycle.

The mean ISS of the patients was 6.1; 62.6% had mild injuries, 29.7% had mode-rate injuries and 7.7% had severe injuries (Table1). Only 411 (30.9%) patients had received prehospital care. The average length of stay in hospital was 6.9 days (range 1–105 days): 54 patients were admitted to the ICU. Glasgow coma scale for 1279 (96%) patients was more than 12 (9–12 indicates moderate brain injury).Only 474 patients (35.6%) had a source of reimbursement.

As regards the anatomical pattern of injuries, injuries to the extremities were the commonest (1185 injuries), followed by craniofacial (256), chest (24), spine (23)

and abdominal injuries (18). The operative procedures carried out are given in Table 2.

Patterns of head and facial injuries are shown in Table 3. Skull fracture was the commonest type with about half being located at the base of skull. Intracranial injuries were detected in 114 patients (focal brain injury, diffuse brain injury, cerebral oedema, concussion, epidural haematoma, subdural haematoma, subarachnoid haematoma, cranial nerve, and crush). Focal brain injury and epidural haematoma were the commonest types of intracranial injuries with 37 (14.4%) and 36 (14.1%) patients respectively suffering these kind of injuries. Motorcyclists who had been wearing a helmet at the time of the incident sustained head injuries less often than non-helmeted riders ($\chi^2 = 7.90$, $P = 0.005$). Only 2.7% of helmeted riders sustained a head injury, compared with 11.2% of riders without a helmet.

Chest trauma was sustained by 24 of the patients. Of these, 11 patients had rib fractures and 7 patients had pneumothorax (4 patients had haemothorax and 2 patients sustained haemopneumothorax). Major abdominal trauma was seen in 18 patients: 4 of these had liver injury and 8 had a spleen tear. There was 1 patient with vena cava vein injury. Renal laceration was present in 3 patients, bladder injury in 1 and rupture of the urethra in 1 patient. Of 16 patients with fracture of the vertebrae, 12 sustained a lumbar fracture. Five patients had dislocation of the vertebrae and 2 sustained injury of the nerve root in the cervical spine.

The distribution of extremities injury is given in Table 4. Most of these injuries were in the lower extremities (73.9%). The commonest musculoskeletal injury was bone fracture; tibial fracture with 509 injuries (49.8%) ranked highest among fractures, followed by femoral and forearm with 203 (19.9%) and 138 (13.5%) respectively. One hundred and seventeen (117) patients suffered from a dislocation with the commonest site being the knee, followed by the hip

Table 2 Operative procedures carried out for injured motorcyclists

Kind of operative procedure	No.	%
Repair of extremity fracture	970	91.9[a]
Craniotomy	33	3.1
Chest tube	13	1.2
Explorary laparatomy	17	1.6
Splenectomy	6	0.6
Repair of intestine	3	0.3
Repair of spleen	2	0.2
Repair of liver	4	0.4
Repair of urethra	1	0.1
Faciotomy	5	0.5
Amputation	1	0.1
Total	1056	100.0

[a]Many fractures were treated only with casting without operative procedure.

Table 3 Distribution of craniofacial injuries in motorcyclists

Injury	No.	%
Skull fracture	83	32.4
Facial fracture	55	21.4
Focal brain injury	37	14.4
Diffuse brain injury	8	3.1
Cerebral oedema	5	2.0
Concussion	6	2.3
Epidural haematoma	36	14.1
Subdural haematoma	15	5.9
Subarachnoid haematoma	3	1.2
Cranial nerve	3	1.2
Eye and orbit	4	1. 6
Crush	1	0.4
Total	256	100.0

Table 4 Distribution of injuries to the extremities in motorcyclists

Site of injury	Fracture		Dislocation		Muscles		Nerves		Vessels		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Humerus	67	6.6	21	17.9	2	6.3	–	–	–	–	90	7.6
Forearm	138	13.5	6	5.1	2	6.3	–	–	–	–	146	12.3
Hand	54	5.2	12	10.3	5	15.6	2	33.3	–	–	73	6.2
Femur	203	19.9	22	18.8	5	15.6	1	16.7	2	25.0	233	19.7
Tibia and fibula	509	49.8	39	33.4	11	34.3	2	33.3	5	62.5	566	47.8
Foot	51	5.0	17	14.5	7	21. 9	1	16.7	1	12.5	77	6.5
Total	1022	86.2	117	9.9	32	2.7	6	0.5	8	0.7	1185	100

and shoulder. There were 49 patients with pelvic ring injury.

There were 28 deaths (2.2%): 25 were drivers (89.2%) and 3 were passengers (10.8%). Of those who died, 27 (96.4%) were male and 1 was female. The mean age was 31.18 years. Head injuries were the prominent cause of death; 19 of the deaths (67.9%) were due to head injuries, 5 (17.9%) were due to abdominal injuries, 2 (7.1%) were due to thoracic injuries, 1 (3.6%) to spinal cord injury and 1 (3.6%) to sepsis. None of the patients who died had been wearing a helmet at the time of the accident. The mean ISS in the fatally-injured group was 45.92 (range 8–75) compared to 6.04 (range 1–30) in those who survived. The commonest place of death was the ER with 16 cases, followed by the ICU and operation room with 10 and 2 cases respectively.

Discussion

In this study, head and abdominal trauma followed by thoracic injury were the main causes of death in motorcyclists. In agreement with previous finding injuries to the head were responsible for the most severe injuries and accounted for the largest proportion of deaths [*8,9*]. Helmet use was infrequent among motorcyclists in our study. Only 115 (8.6%) had been wearing a helmet at the time of the accident. Of those who died, none had been wearing a helmet at time of the accident. In addition there were 54 patients admitted in the ICU and 40 of these (74.1%) had sustained a head trauma. Thus failure to wear a helmet resulted in a significantly higher incidence of cranial injury and death among our patients involved in motorcycle crashes. Helmets are the best-evaluated way to reduce motorcycle deaths and injuries [*14,15*]. They are 29% to 35% effective at preventing motorcycle deaths. They also significantly reduce the frequency nonfatal brain injury [*16*]. A mandatory helmet law does not currently exist in our country and the prevalence of voluntary helmet use is low. A national mandatory helmet use law is clearly needed to reduce morbidity and mortality associated with riding motorcycles.

Many factors influence the use of helmets by motorcyclists of which weather condition is one of them [*17*]. Among our patients, helmets were used less frequently in the spring and summer months perhaps

because of the warmer weather. An innovation in design of helmets for warm climates could improve motorcyclists' helmet usage.

Our results confirm earlier observations that the anatomic sites most commonly injured in motorcycle crashes are the extremities. Lower extremity fractures are reported to be common in motorcycle crashes which is similar to our findings [*1,6*].

Collision with other vehicles (72.5%) was the commonest mechanism of injury in our study. In addition, a high proportion of the deaths occurred in the ER and operating room shortly after admission to hospital. This indicates a high severity of injuries in these patients which may be related to high speed or lack of safety devices.

According to previous studies, accident prevention and injury reduction are more effective than hospital treatment in reducing the death rate amongst motorcyclists. Towards this end we would strongly advocate a national mandatory helmet requirement for all motorcyclists. Design of new helmet to suit the weather conditions in our country might improve the usage of helmets by motorcyclists. Protection of the lower extremities through use of different types of devices such as crash bars and hard leg protectors with cage-like structures for the leg or even long leather boots seems advisable.

In the present study, only 411 (30.9%) patients had received prehospital care. Tehran's emergency medical services (EMS) system is responsible for prehospital care in trauma patients. Recently (2003–2004) the EMS system has increased its number of staff and have been equipped with many new, well equipped ambulances. It is hoped this will improve the quality and quantity of prehospital care of trauma patients in Tehran.

There are some limitations to our study. First, this was a hospital-based study, so we cannot report the incidence of motorcycle-related accidents in the country. A community-based study in this field could add more to our knowledge regarding the number and types of accidents and the mechanisms of injuries. Secondly, the study does not include information on patients who died before reaching hospital, as we did not have access to prehospital data for these patients. These cases are directly referred to the Legal Medicine Organization. So the mortality reported in our study probably underestimates the real rate.

References

1. Rivara FP, Grossman DC, Cummings P. Injury prevention. Medical progress, 1997, 337(8):543–8.
2. Kopjar B. Moped injuries among adolescents: a significant forgotten problem? Accident; analysis and prevention, 1999, 31(5):473–8.
3. Lateef F. Riding motorcycles: is it a lower limb hazard? Singapore medical journal, 2002, 43(11):566–9.
4. Lin MR et al. A longitudinal study of risk factors for motorcycle crashes among junior college students in Taiwan. Accident; analysis and prevention, 2003, 35(2): 243–52.
5. Tsai MC, Hemenway D. Effect of the mandatory helmet law in Taiwan. Injury prevention, 1999, 5(4):290–1.
6. Ankarath S et al. Injury patterns associated with mortality following motorcycle crashes. Injury, 2002, 33(6):473–7.
7. Preusser DF, Williams AF, Ulmer RG. Analysis of fatal motorcycle crashes: crash typing. Accident; analysis and prevention, 1995, 27(6):845–51.

8. Sarkar S, Peek C, Kraus F. Fatal injuries in motorcycle riders according to helmet use. Journal of trauma, 1995, 38(2): 242–5.

9. Peek C. Lower extremity injuries from motorcycle crashes: A common cause of preventable injury. Journal of trauma, 1994, 37(3):358–64.

10. Wyatt JP et al. Injury analyses of fatal motorcycle collisions in south-east Scotland. Forensic science international, 1999, 104(2–3):127–32.

11. McCoy GF. A review of fatal road accidents in Oxfordshire over a 2-year period. Injury, 1989, 20:65–8.

12. Stella J, Cooke C, Sprivulis P. Most head injury related motorcycle crash deaths are related to poor riding practices. Emergency medicine, 2002, 14(1):58–61.

13. Zargar M, Modaghegh MH, Rezaishiraz H. Urban injuries in Tehran: demography of trauma patients and evaluation of trauma care. Injury, 2001, 32(8):613–7.

14. International statistical classification of diseases and related health problems (ICD–10). Geneva, World Health Organization, 1992.

15. Ferrando J et al. Impact of a helmet law on two wheel motor vehicle crash mortality in a southern European urban area. Injury prevention, 2000, 6(3):184–8.

16. Lawrence BA, Max W, Miller TR. Costs of injuries resulting from motorcycle crashes: a literature review. Washington, DC, US Department of Transportation, National Highway Traffic Safety Administration, 2002. Available at: http://www.nhtsa.dot.gov/people/injury/pedbimot/motorcycle/Motorcycle_HTML/trd.html (accessed 31 October 2005).

17. Skalkidou A et al. Factors affecting motorcycle helmet use in the population of greater Athens, Greece. Injury prevention, 1999, 5:264–7.