Risk factors associated with facial fractures

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Abstract: The aim of the present study was to identify risk factors for facial fractures in patients treated in the emergency department of a hospital. The medical charts of 1121 patients treated in an emergency ward over a three-year period were analyzed. The independent variables were gender, age, place of residence (urban or rural area) and type of accident. The dependent variables were fractured mandible, zygoma, maxilla, nasal bone and more than one fractured facial bone. Statistical analysis was performed using the chi-square test ($\alpha < 0.05$), univariate and multivariate Poisson distributions and the logistic regression analysis ($p < 0.20$). Maxillofacial trauma was recorded in 790 charts (70.5%), with 393 (35.1%) charts reporting facial fractures. Motorcycle accidents were found to be the main risk factor for mandibular fractures (PR = 1.576, CI = 1.402–1.772) and simultaneous fractures of more than one facial bone (OR = 4.625, CI = 1.888–11.329) as well as the only risk factor for maxillary bone fractures (OR = 11.032, CI = 5.294–22.989). Fractures of the zygomatic and nasal bones were mainly associated with accidents involving animals (PR = 1.206, CI = 1.104–1.317) and sports (OR = 8.710, CI = 4.006–18.936), respectively. The determinant for the majority of facial fractures was motorcycle accidents, followed by accidents involving animals and sports.

Descriptors: Maxillofacial Injuries; Accidents; Risk Factors.

Introduction

Maxillofacial trauma is one of the major challenges for public healthcare services due to the a high incidence rate and financial cost.[1] The injuries result from falls, physical aggression and accidents involving motor vehicles, bicycles, animals and sports.[2,3] The epidemiology of trauma is determined by the geographic area, demographic and socioeconomic factors and the period of investigation.[4-7]

The most frequent maxillofacial injuries are fractures of the mandible and bones of the middle third of the face.[3,8-10] Motorcycle accidents, the male gender and the third decade of life are reported to be the main risk factors for facial fractures.[9,10]

The identification of groups at risk, the assessment of the needs of healthcare services and the development of preventive programs and clinical protocols for the treatment of maxillofacial trauma depend directly on knowledge regarding the specific situation of different communities. A critical analysis of the literature reveals that most studies on

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facial injuries are limited to data of a predominantly descriptive nature, which compromises the quality of the evidence and the correct interpretation of the findings.

The aim of the present study was to identify risk factors for facial fractures in patients treated in the emergency department of a hospital.

Methodology

A retrospective study was performed and involved a chart review of patients treated in the emergency department of a Regional Hospital in the city of Guanhães, Minas Gerais, Brazil, between January 2005 and December 2007. This hospital is a referral center for 23 municipalities in the Rio Doce valley and treats patients from both urban and rural areas, covering an area of 12,745.1 km^2 and encompassing a population of 238,797 inhabitants.

The inclusion criterion was a completed patient chart. A total of 1121 charts were analyzed with regards to socio-demographic data, fractured facial bones and etiology.

Descriptive statistics were performed for the socio-demographic data, maxillofacial trauma (soft tissue injuries, facial bone fractures and dentoalveolar trauma) and type of accident. The chi-square and Fisher's exact tests were used to determine associations between facial fractures (mandible, zygoma, maxilla, nose and more than one facial bone) and gender, age, place of residence (urban or rural area) and type of accident. The level of significance was set at 5%. Univariate and multivariate regression analyses were performed for the investigation of risk factors for facial fractures. A regression analysis was performed for each fractured facial bone (dependent variable). To avoid the overestimation of the odds ratio (OR), Poisson analyses were performed when the type of trauma was greater than 10% in the population studied. When the outcome frequency was less than 10%, a logistic regression analysis was performed. Independent variables with a p-value < 0.20 using the chi-square test were incorporated into the regression analysis. The Statistical Package for Social Sciences (SPSS for Windows, version 15.0, SPSS Inc., Chicago, USA) was used for the analyses.

The present study was approved by the Research Ethics Committee of the public hospital at which it was carried out.

Results

Maxillofacial trauma was recorded in 790 charts (70.5%), with 393 (35.1%) charts reporting facial fractures. Table 1 displays the data on the socio-demographic variables and types of accidents. The most frequently fractured facial bone was the mandible (18.0%), the most frequent dentoalveolar trauma was concussion (78.0%) and the most frequent soft tissue injury was contusion (82.4%).

Table 2 displays the prevalence of facial bone fractures according to gender. Fractures of the mandible and zygomatic bone were more prevalent beginning at 13 years of age (Table 3). Mandibular fractures were the most frequent type of fracture among individuals involved in automobile and mo-

Table 1 - Absolute and relative frequency of socio-demographic variables and types of accidents, Guanhães, Brazil, 2005-2007 (n = 790).

Variables	n (%)
Gender	
Male	537 (68.0)
Female	253 (32.0)
Age	
< 13 years	83 (10.5)
13 to 19 years	205 (25.9)
20 to 29 years	317 (40.1)
30 years or older	185 (23.4)
Place of residence	
Urban area	534 (67.6)
Rural area	256 (32.4)
Type of accident	
Automobile	59 (7.5)
Motorcycle	72 (9.1)
Bicycle	87 (11.0)
Involving animal	111 (14.1)
Work-related	40 (5.1)
Violence	150 (19.0)
Sports	162 (20.5)
Fall	115 (14.6)

Table 2 - Distribution of facial fractures based on gender, Guanhães, Brazil, 2005-2007 (n = 393).

Type of facial fracture	Prevalence within male gender n (%)	Prevalence within female gender n (%)	Total (%)
Mandible	101 (18.8)	41 (16.2)	142 (18.0)
Zygoma	91 (16.9)	11 (4.3)	102 (12.9)
Maxilla	32 (6.0)	10 (4.0)	42 (5.3)
Nose	54 (10.1)	19 (7.5)	73 (9.2)
More than one facial bone	30 (5.6)	4 (1.6)	34 (4.3)

Table 3 - Distribution of facial fractures based on age group, Guanhães, Brazil, 2005-2007 (n = 393).

Type of facial fracture	Age group				
	< 13 years n (%)	13–19 years n (%)	20–29 years n (%)	30 years or older n (%)	Total (%)
Mandible	5 (6.0)	30 (14.6)	74 (23.3)	33 (17.8)	142 (18.0)
Zygoma	3 (3.6)	30 (14.6)	42 (13.2)	27 (14.6)	102 (12.9)
Maxilla	3 (3.6)	7 (3.4)	16 (5.0)	16 (8.6)	42 (5.3)
Nose	8 (9.6)	19 (9.3)	26 (8.2)	20 (10.8)	73 (9.2)
More than one facial bone	2 (2.4)	4 (2.0)	10 (3.2)	18 (9.7)	34 (4.3)

Table 4 - Distribution of facial fractures based on type of accident, Guanhães, Brazil, 2005-2007 (n = 393).

Type of facial fracture	Automobile accident n (%)	Motorcycle accident n (%)	Bicycle accident n (%)	Accident involving animal n (%)	Work accident n (%)	Violence n (%)	Sports n (%)	Falls n (%)	Total n (%)
Mandible	14 (23.7)	38 (52.8)	13 (14.9)	34 (30.6)	0 (0.0)	42 (28.0)	0 (0.0)	1 (0.9)	142 (18.0)
Zygoma	2 (3.4)	7 (9.7)	4 (4.6)	33 (29.7)	6 (15.0)	21 (14.0)	28(17.3)	1 (0.9)	102 (12.9)
Maxilla	3 (5.1)	17 (23.6)	4 (4.6)	5 (4.5)	3 (7.5)	6 (4.0)	3 (1.9)	1 (0.9)	42 (5.3)
Nose	0 (0.0)	3 (4.2)	13 (14.9)	1 (0.9)	1 (2.5)	22 (14.7)	29(17.9)	4 (3.5)	73 (9.2)
More than one facial bone	2 (3.4)	8 (11.1)	5 (5.7)	6 (5.4)	3 (7.5)	7 (4.7)	3 (1.9)	0 (0.0)	34 (4.3)

torcycle accidents (23.7% and 52.8%, respectively). Of those subjects involved in bicycle accidents 14.9% suffered mandibular fractures, and 14.9% suffered nasal bone fractures. Of those subjects involved in accidents with animals, 30.6% suffered mandibular fractures, and 29.7% suffered zygomatic bone fractures. Of those subjects who were victims of violence, 28.0% suffered mandibular fractures. Of those subjects involved in sport-related accidents, 17.3% suffered zygomatic bone fractures, and 17.9% suffered nasal bone fractures (Table 4).

Motorcycle accident was the main risk factor for fractures of the mandible (PR = 1.576, CI = 1.402–1.772) (Table 5) and more than one facial bone (OR = 4.625, CI = 1.888–11.329), and it was the only risk factor for maxillary fractures (OR = 11.032, CI = 5.294–22.989) (Table 6). Fractures of the zygomatic bone and nose were mainly associated with accidents involving animals (PR = 1.206, CI = 1.104–1.317) and sports (OR = 8.710, CI = 4.006–18.936), respectively (Table 5 and 6).

Discussion

The occurrence of maxillofacial trauma was more prevalent in male patients and in the age group between 20 and 29 years, which corroborates findings described in the literature.[10-12]

Table 5 - Univariate and multivariate Poisson regression for fractures of the mandible and zygoma, Guanhães, Brazil, 2005-2007 (n = 393).

Dependent variables	Independent variables	Unadjusted PR	95% CI	p	Adjusted PR	95% CI	p
Mandibular fracture	Motorcycle accident	1.811	1.282-2.558	**0.001**	1.576	1.402-1.772	**0.000**
	Accident involving animal	1.212	0.956-1.538	0.113	1.268	1.159-1.388	**0.000**
	Violence	1.172	0.953-1.441	0.132	1.231	1.139-1.329	**0.000**
	Age						
	• < 13 years	1			1		
	• 13 – 19 years	0.918	0.855-0.984	**0.017**	0.983	0.906-1.066	0.681
	• 20 – 29 years	0.841	0.785-0.901	**0.000**	0. 931	0.860-1.007	0.076
	• 30 years or older	0.889	0.824-0.958	**0.002**	0.958	0.879-1.044	0.330
Zygomatic fracture	Place of residence						
	• Urban area	1.114	0.946-1.311	0.194	1.057	1.003-1.115	**0.040**
	• Rural area	1			1		
	Accident involving animal	1.278	1.010-1.618	**0.041**	1.206	1.104-1.317	**0.000**
	Sports	1.066	0.883-1.288	0.504	1.111	1.040-1.187	**0.002**
	Age						
	• < 13 years	1			1		
	• 13 – 19 years	0.896	0.841-0.954	**0.001**	0.928	0.869-0.991	**0.025**
	• 20 – 29 years	0.908	0.860-0.959	**0.001**	0.925	0.874-0.979	0.007
	• 30 years or older	0.896	0.840-0.956	**0.001**	0.906	0.847-0.968	**0.003**

PR: prevalence ratio. 95% CI: 95% confidence interval.

The incidence of facial fractures tends to increase with age,[13-15] which was confirmed in the present study. A comparison of individuals under 13 years of age and other age groups revealed a considerable increase in the number of fractures of the mandible and zygomatic bone. The lower incidence of facial fractures among children may be explained by the greater protection offered by the family, which leads to less exposure to injuries stemming from accidents. However, social habits change as a child grows, including school attendance and participation in sports and activities that involve bodily contact, thereby increasing the risk of trauma.[16] Another explanation is the bone structure of children. The lack of pneumatization of the paranasal sinuses and the presence of an ample tooth to bone proportion tend to make a child's facial skeleton more elastic and stable. Moreover, the suture lines are flexible and children have ample fat pads that absorb the impact and reduce the force transmitted to the bone architecture.[17-19]

The mandible was the most commonly affected facial bone (18.1%), which confirms the findings of previous studies.[5,6,9] The greater frequency of mandibular fractures may be explained by the mobility of this structure and its involvement in complex physiological functions due to its prominent position in relation to the facial skeleton as well as its lack of protection.[9,20] A greater frequency of this type of injury is found in children, adolescents and adults alike.[7,9]

Mandibular fractures are more frequently associated with motorcycle accidents[7,9] and physical aggression.[12] In the present study, mandibular fractures were mainly related to motorcycle accidents (52.8%), followed by accidents involving animals (30.6%) and violence (28.0%). The univariate Poisson regression revealed that motorcycle accidents were the only predictive factor for mandibular fractures. However, the multivariate analysis indicated

Table 6 - Univariate and multivariate logistic regression for fractures of the maxilla, nose and more than one facial bone, Guanhães, Brazil, 2005-2007 (n = 393).

Dependent variables	Independent variables	Unadjusted OR	95% CI	p	Adjusted OR	95% CI	p
Maxillary fracture	Motorcycle accident	8.568	4.364 -16.820	**0.000**	11.032	5.294-22.989	**0.000**
	Age						
	• < 13 years	1			1		
	• 13 – 19 years	0.943	1.238 - 3.737	0.933	0.811	0.196 - 3.356	0.772
	• 20 – 29 years	1.417	0.403 - 4.985	0.587	0.901	0.242 - 3.351	0.876
	• 30 years or older	2.525	0.715 - 8.914	0.150	2.779	0.755-10.222	0.124
Nasal fracture	Place of residence						
	• Urban area	1			1		
	• Rural area	0.466	0.255 - 0.851	**0.013**	0.596	0.321 - 1.108	0.102
	Bicycle accident	1.883	0.987 - 3.592	0.055	7.008	2.881-17.049	**0.000**
	Violence	1.985	1.162 - 3.390	**0.012**	6.857	3.068-15.326	**0.000**
	Sports	2.894	1.746 - 4.796	**0.000**	8.710	4.006-18.936	**0.000**
Fracture of more than one facial bone	Motorcycle accident	3.327	1.447 - 7.651	**0.005**	4.625	1.888-11.329	**0.001**
	Age						
	• < 13 years	1			1		
	• 13 – 19 years	0.806	0.145 - 4.487	0.805	0.749	0.133 - 4.208	0.742
	• 20 – 29 years	1.319	0.283 - 6.140	0.724	1.035	0.218 - 4.925	0.965
	• 30 years or older	4.365	0.989 -19.268	0.052	4.532	1.018-20.186	**0.047**

OR: odds ratio. 95% CI: 95% confidence interval.

that accidents involving animals and violence were also causes for this type of injury.

The lowest incidence rates of mandibular fractures were found among individuals who had suffered an automobile (23.7%) or a bicycle accident (14.9%). According to Muñante-Cárdenas *et al.*,[13] the most common causes of mandibular fractures in children and adolescents are bicycle accidents and falls. However, in another study involving Brazilian subjects, soft tissue abrasions, hematomas and dentoalveolar traumas were more commonly associated with bicycle accidents. According to the authors, the explanation for this is in the lesser force of impact experienced during a bicycle accident.[9]

Fracture of the zygomatic bone was more prevalent in accidents involving animals and sports (29.7% and 17.3%, respectively). Our study confirmed these trauma mechanisms as risk factors for this type of injury. A study involving Malaysian subjects showed that 53.6% of zygomatic fractures were due to motorcycle accidents. Individuals involved in this type of accident had a significantly greater incidence of facial fractures.[10,19]

In the present study, motorcycle accidents accounted for a large percentage of mandibular fractures (52.8%). Of these accidents, 23% also had maxillary fractures. In the multivariate logistic regression, individuals who had suffered a motorcycle accident had an 11-fold increase in the risk of also suffering a maxillary fracture. Violence and accidents involving animals accounted for 24.9% and 20.1% of facial fractures, respectively. The large percentage of accidents involving animals stems from the region in which the study was conducted, as the main source of income in this region is livestock farming.

In the present study, fractures of the maxilla and more than one facial bone were more prevalent in motorcycle accidents. Multivariate analysis revealed that individuals who had motorcycle accidents had a

4.62-fold greater risk of suffering fractures in more than one facial bone. A study relating facial trauma to motorcycle accidents found that a considerable number of motorcyclists wear a helmet without the protective visor or wear the helmet in an incorrect fashion and others experience impact of the face against the helmet.[9] Another study involving Brazilian subjects found that 40% of motorcyclists who had suffered accidents were not wearing a helmet, and the majority (60.5%) of victims who wore a helmet were not using a protective visor.[4]

Sports, bicycle accidents and violence were the trauma mechanisms that most frequently led to nasal bone fractures and were confirmed in the multivariate logistic regression as risk factors for this type of injury. Bicycle accidents and violence increased the likelihood of nasal bone fractures by approximately 7-fold, while accidents related to sports resulted in an 8-fold increase. According to the literature, even when cyclists wear helmets, the face remains unprotected, as protection is restricted to the head (with a reduction in the severity of head trauma) and in part to the upper face.[21] While falls accounted for a significant percentage of facial fractures in our study (14.6%), these events did not indicate risk factors for these types of injuries, as only seven individuals suffered facial fractures from a fall. Yamamoto *et al.*[19] assessed facial fractures resulting from falls and found that two thirds of these fractures involved the mandible.

The findings in our study highlight the importance of public awareness regarding etiology and preventative measures for maxillofacial trauma. Moreover, this study provides consistent evidence regarding the risk factors of facial fractures and can serve as a reference for communities with a similar profile.

Conclusion

Motorcycle accident was the main cause for the majority of facial fractures, followed by accidents involving animals and sports.

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