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Facial fractures in children and adolescents: a retrospective study of 3 years in a hospital in Belo Horizonte, Brazil

Bruno Ramos Chrcanovic[1], Mauro Henrique Nogueira Guimarães Abreu[2], Belini Freire-Maia[3], Leandro Napier Souza[4]

[1]Maria Amélia Lins Hospital, Belo Horizonte; [2]Universidade Federal de Minas Gerais, Belo Horizonte; [3]Pontifícia Universidade Católica de Minas Gerais, Belo Horizonte; [4]Centro Universitário Newton Paiva, Belo Horizonte, Brazil

Correspondence to: Bruno Ramos Chrcanovic, Av. Raja Gabaglia 1000/1209, Gutierrez, Belo Horizonte, Minas Gerais, CEP 30441-070, Brazil
Tel.: +55 31 33356892
Fax: +55 31 25151579
e-mail: brunochrcanovic@hotmail.com

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Abstract – *Aim*: The purpose of this study was to review the etiology, incidence and treatment of selected oral and maxillofacial fractures in children in Belo Horizonte, Brazil, during a period of 3 years. *Materials and methods*: The data collected for this study included age, gender, etiology, date of trauma, associated maxillofacial trauma, anatomic site of fracture and treatment. The analysis involved descriptive statistics and chi-squared test, Bonferroni test, Kolmogorov–Smirnov, Kruskal–Wallis and Mann–Whiney tests and analysis of variance. *Results and conclusions*: This study examined 566 facial fractures in 464 children of 18 years of age or less. The majority of fractures were observed in children within the age group of 13–18 years of age. Bicycle accidents were the major cause of trauma, followed by falls. The mandible was found to be the most common fractured bone in the facial skeleton, followed by the nose. A conservative approach was applied in most cases.

Maxillofacial fractures in the pediatric and adolescent age groups are relatively uncommon when compared with those occurring in adults (1), because the occurrence of fractures tends to increase with age. In addition, in the USA, surpassing all other major childhood diseases in frequency and consequence, trauma affects one in every three individuals annually (2). The main causes of facial fractures in children up to 18 years of age include falls (3–11) and road vehicle accidents (2, 12–18).

The aim of this article was to evaluate the frequency of facial fractures in children and adolescents among those who presented maxillofacial trauma in a reference hospital of the metropolitan region of Belo Horizonte, Brazil, as well as to assist the clinician in the assessment of this unique and highly specialized area of traumatology. In this light, this study evaluated various demographic and clinical aspects of patients and factors associated with the etiology of maxillofacial trauma and the treatment of maxillofacial fractures.

Material and methods

The Oral and Maxillofacial Surgery Unit at Maria Amélia Lins Hospital in Belo Horizonte, Brazil, provides maxillofacial trauma treatment for a large number of people in the Metropolitan Region of Belo Horizonte, a population of 5.1 million inhabitants. This study was based on the data pertaining to those patients who had suffered trauma between 1 January 2000 and 31 December 2002, and who had been attended to at Maria Amélia Lins Hospital. Data were collected from the medical files of the patients by a single trained researcher.

The cause of injury was divided into five main categories: (i) vehicles, which included accidents involving automobiles, motorcycles and bicycles, as well as pedestrians; (ii) violence, which included interpersonal violence, fire and white weapons violence; (iii) falls; (iv) sports injuries; and (v) others, which included pathological fractures, occupational accidents, domestic accidents, suicide attempts, accidents with animals, sudden illness (such as a heart attack or an epileptic fit), fractures caused by teeth extraction and unknown etiology.

Three dependent variables were analyzed: presence or absence of maxillofacial fractures, fractures etiology and type of treatment. The independent variables for the presence/absence of fractures were: gender, age and etiology. The independent variables in the fracture etiology included age, gender, number of fractures and type of treatment. Finally, the type of treatment included the independent variables of gender and age.

The anatomical location of the fractures and the time of trauma were also measured (dichotomized between the weekend and the day of week), for the purpose of descriptive analysis.

The statistical analysis, performed using the Statistical Package for Social Sciences (SPSS) version 17.0 software

(SPSS Inc., Chicago, IL, USA), involved the evaluation of the measures of central tendency and variability and the calculation of proportions. The Kolmogorov–Smirnov statistic and the Lillefors correction were carried out to assess the normal distribution for the number of fractures and age variables. Pearson's chi-squared test was also used to compare proportions with the Bonferroni's correction. Kruskal–Wallis and Mann–Whitney tests, together with Bonferroni's correction, were performed to compare quantitative and categorical variables. The degree of statistical significance was considered $P < 0.05$, except when using Bonferroni's correction.

The present study was approved by the Research Ethics Committee of FHEMIG/DIREP (Fundação Hospitalar de Minas Gerais/Diretoria de Ensino e Pesquisa), under number 135/2002.

Results

Descriptive results

In the 3 years of this study, 3345 patients were diagnosed with maxillofacial trauma, 2736 (81.79%) of whom presented fractures of one or more facial bones. In addition, 680 patients were 18 years of age or less, 464 (68.24%) of whom presented maxillofacial fractures. Thus, 16.96% of the entire sample of trauma patients with maxillofacial fractures (464 of 2,736) consisted of pediatric or adolescent patients. Of a total of 2736 patients with facial fractures, 74 (2.70%) affected the age group of 0–6 years of age (Table 1). The patients of 12 years of age or less represented 6.83% of the total number of patients.

The mean age of children and adolescents with maxillofacial trauma ($n = 680$) was equal to 12.0 (± 5.0). The median age was 13.0. Age did not present a normal distribution (Kolmogorov–Smirnov statistic together with Lillefors' correction; $P < 0.001$).

Fractures were more frequent in the age group of 13–18 years of age (227 of 464, 59.70%; from 0 to 6 years of age: $n = 74$, 15.95%; from 7 to 12 years of age: $n = 113$, 24.35%) (Table 1). Males accounted for 77.2% ($n = 358$) of all facial fractures. The male to female ratio was found to be 3.38:1. More than one-third of the fracture cases (37.5%) occurred at weekends.

There were a total of 566 facial fractures in the 464 patients, averaging 1.21 fractures per patient (1.22 female; 1.21 male). The number of fractures showed no normal distribution (Kolmogorov–Smirnov statistic together with Lillefors' correction; $P < 0.001$). The most common fractures in this study included mandibular fractures ($n = 227$, 40.11%), followed by nose fractures ($n = 160$, 28.26%) and zygomatic complex and arch fractures ($n = 78$, 13.78%). In the mandible, the most commonly affected were the condyles (Table 2). Seventeen (3.01%) fractures of the midface (FNOE + Le Fort types) were recorded in the present study. The major cause of maxillofacial fractures in this study was caused by vehicle accidents, comprising 44.61% of the entire sample (207 of 464). The second most common cause was falls (21.77%, 101 of 464) (Table 3).

Table 1. Distribution of patients by gender in the different age groups, Belo Horizonte, Brazil, 2000–2002

Age groups (years)	Male (%)	Female (%)	Total (%)	Male:female ratio
0–6	48 (13.41)	26 (24.53)	74 (15.95)	1.85:1
7–12	86 (24.02)	27 (25.47)	113 (24.35)	3.18:1
13–18	224 (62.57)	53 (50.00)	277 (59.70)	4.23:1
Total	358 (100.00)	106 (100.00)	464 (100.00)	3.38:1

Table 2. Location of mandibular fractures, Belo Horizonte, Brazil, 2000–2002

Fracture location	Total (%)
Mandibular condyle	92 (16.25)
Mandibular parasymphysis	40 (7.06)
Mandibular angle	34 (6.01)
Mandibular body	31 (5.48)
Mandibular symphysis	23 (4.06)
Coronoid process	1 (0.18)
Mandibular ramus	2 (0.35)
Mandible ?[1]	4 (0.71)
Mandible total	227 (40.11)

[1]Location of mandibular fracture not mentioned in medical files.

Factors associated with the presence or absence of maxillofacial fractures

The median age of patients with maxillofacial fractures (14.00 years) was statistically superior to those without fracture (9.00 years) (Mann–Whitney test, $P < 0.001$).

When comparing the proportion of patients with maxillofacial fractures between males and females, there is no association between these variables (Pearson's chi-squared test, $P = 0.180$) (Table 4).

However, the proportion of fractures among the various etiologies investigated is statistically different (Pearson's chi-squared test, $P < 0.001$).

After Bonferroni's correction, it could be observed that the proportion of patients with facial fracture after a

Table 3. Distribution of etiologic factors of patients with facial fractures in different age groups, Belo Horizonte, Brazil, 2000–2002

Etiology	0–6 years old (%)	7–12 years old (%)	13–18 years old (%)	Total, *n* (%)
Vehicles	17 (22.97)	59 (52.21)	131 (44.67)	207 (44.62)
Bicycle	9 (12.16)	39 (34.51)	73 (26.35)	121 (26.08)
Auto	8 (10.81)	20 (17.70)	40 (14.44)	68 (14.66)
Moto	0 (0.00)	0 (0.00)	18 (6.50)	18 (3.88)
Falls	49 (66.22)	26 (23.01)	26 (9.39)	101 (21.77)
Violence	3 (4.05)	9 (7.97)	78 (28.17)	90 (19.40)
Sports	0 (0.00)	6 (5.31)	29 (10.47)	35 (7.54)
Others	5 (6.76)	13 (11.50)	13 (4.68)	31 (6.67)
Total	74 (100.00)	113 (100.00)	277 (100.00)	464 (100.00

Auto, automobile accidents; Moto, motorcycle accidents.

Table 4. Distribution of patients with or without fractures according to etiology and gender, Belo Horizonte, Brazil, 2000–2002

	With fracture (%)	Without fracture (%)	Total (%)	*P*-value
Gender				
Male	358 (69.65)	156 (30.35)	514 (100.0)	0.180
Female	106 (63.86)	60 (36.14)	166 (100.0)	
Etiology				
Vehicles[a]	207 (72.89)	77 (27.11)	284 (100.0)	<0.001
Falls[b]	101 (54.30)	85 (45.70)	186 (100.0)	
Violence[a]	90 (76.27)	28 (23.73)	118 (100.0)	
Sports[a]	35 (81.40)	8 (18.60)	43 (100.0)	
Others[a,b]	31 (63.27)	18 (36.73)	49 (100.0)	

Different letters indicate statistically significant differences after Bonferroni's correction ($P < 0.005$), using the Pearson's chi-squared test.

fall (101 of 186 – 54.30%) was statistically lower than all other causes (Pearson's chi-squared test, $P < 0.002$), except in the case of 'other' etiologies (Pearson's chi-squared test, $P = 0.26$). Thus, the etiology 'fall' presented the lowest morbidity.

Factors associated with etiology

The results were presented for the total number of patients, with and without fractures ($n = 680$), seeking the service of Oral and Maxillofacial Surgery at the Maria Amélia Lins Hospital of Belo Horizonte.

The age was associated with the etiology of fractures (Kruskal–Wallis test, $P < 0.001$). After comparing the age of the patients, according to etiology after Bonferroni's correction, it could be observed that the groups have statistically different ages (Mann–Whitney test, $P < 0.001$), except when comparing the age between the groups 'fall' and 'other' (Mann–Whitney test, $P = 0.008$) and 'vehicles' and 'sports' (Mann–Whitney test, $P = 0.399$) (Table 5).

There was a statistical association between gender and etiology (Pearson's chi-squared test, $P = 0.012$). After Bonferroni's correction, the proportion of females attended to for falls (60 of 186 – 32.26%) was higher than the proportions of females attending to for violence

Table 5. Minimum, median and maximum age according to etiology, Belo Horizonte, Brazil, 2000–2002

	Age			
	Minimum	Median	Maximum	*P*-value
Etiology				
Vehicles[b]	1	14.00	18	<0.001
Falls[a]	0	6.00	18	
Violence[c]	1	17.00	18	
Sports[b]	5	14.00	18	
Others[a]	1	10.00	18	

Different letters indicate statistically significant differences after Bonferroni's correction ($P < 0.005$), using the Mann–Whitney test.

Table 6. Etiologic distribution of maxillofacial trauma cases according to gender, Belo Horizonte, Brazil, 2000–2002

	Gender			
	Male (%)	Female (%)	Total (%)	*P*-value
Etiology				
Vehicles[b]	225 (79.23)	59 (20.77)	284 (100.00)	0.012
Falls[a]	126 (67.74)	60 (32.26)	186 (100.00)	
Violence[b]	97 (82.20)	21 (17.80)	118 (100.00)	
Sports[a,b]	33 (76.74)	10 (23.26)	43 (100.00)	
Others[a,b]	33 (67.35)	16 (32.65)	49 (100.00)	
Total			680 (100.00)	

Different letters indicate statistically significant differences after Bonferroni's correction ($P < 0.005$), using the Pearson's chi-squared test.

(Pearson's chi-squared test, $P = 0.005$) or for vehicle accidents (Pearson's chi-squared test, $P = 0.005$). All other comparisons were statistically similar (Pearson's chi-squared test, $P > 0.005$) (Table 6).

The association between etiology and type of treatment were made considering only patients with fractures ($n = 464$). An association could be observed between these variables (Pearson's chi-squared test, $P < 0.001$). After Bonferroni's correction, the proportion of patients with conservative treatment was greater among those whose fracture had been caused by a fall when compared with vehicle etiology (Pearson's chi-squared test, $P < 0.001$) and other causes (Pearson's chi-squared test, $P = 0.001$) (Table 7).

The etiology was associated with the number of fractures (Kruskal–Wallis test, $P < 0.001$). The minimum number of fractures was 1 for all etiologies. The maximum number of fractures varied according to etiology: 'violence' and 'sports' (2 fractures), 'falls' and 'others' (3 fractures), and 'vehicles' (4 fractures). After Bonferroni's correction, the number of fractures compared with etiology showed no statistically different numbers among the groups, except when comparing the groups 'fall' and 'violence' (Mann–Whitney test, $P < 0.001$), 'fall' and 'vehicles' (Mann–Whitney test, $P < 0.001$), and 'fall' and 'sports' (Mann–Whitney test, $P = 0.001$).

Table 7. Etiologic distribution of maxillofacial fractures cases according to treatment, Belo Horizonte, Brazil, 2000–2002

	Type of treatment			
	Surgical treatment	Conservative treatment	Total	*P*-value
Etiology				
Vehicles[b]	97 (46.86)	110 (53.14)	207 (100.0)	<0.001
Falls[a]	24 (23.76)	77 (76.24)	101 (100.0)	
Violence[a,b]	36 (40.00)	54 (60.00)	90 (100.0)	
Sports[a,b]	9 (25.71)	26 (74.29)	35 (100.0)	
Others[b]	17 (54.84)	14 (45.16)	31 (100.0)	
Total			464 (100.0)	

Different letters indicate statistically significant differences after Bonferroni's correction ($P < 0.005$), using the Mann–Whitney test.

Factors associated with the type of treatment

Regarding the type of treatment conducted on patients with facial fractures, females and males were more subject to non-surgical treatment (65.09% and 59.22%, respectively; for the entire sample of patients with fractures: 60.56%). There was no statistically significant difference in the association between treatments for patients with fractures and gender (Pearson's chi-squared test, $P = 0.28$). However, the difference was statistically significant for the association between type of treatment and age of the patients (Pearson's chi-squared test, $P < 0.001$). The median age of patients with fractures was higher in those who underwent the surgical treatment (16.00 and 13.00 years, surgical and non-surgical treatment, respectively).

Discussion

In this study, pediatric and adolescent facial traumas were evaluated in 680 children of 18 years of age or less (464 patients with fractures) with a total of 566 maxillofacial fractures over a 3-year period. The results showed that the frequency of maxillofacial fractures in children in the studied population was relatively low, thereby confirming findings from earlier studies (12, 19) that fractures in children are uncommon. Of a total of 2736 patients with facial fractures, 74 (2.70%) could be found in the age group of 0–6 years of age (Table 1). Patients of 12 years of age or less represented 6.83% of the total number of patients. In contrast, 16.96% of the subjects in this study were children and adolescents (0–18 years of age), which is consistent with many previous reports (20–22).

Younger children were more prone to maxillofacial trauma without fractures (median age = 9.00; $P < 0.001$), whereas maxillofacial trauma with fractures tend to occur more commonly in older children (median age = 14.00; $P < 0.001$). Facial fractures seem to be less common in children younger than 6 years of age.

In an analysis of 1500 facial fractures, Rowe (23) found that less than 5% of the patients were children of less than 12 years of age and only 0.87% were children younger than 6 years of age, which is in agreement with findings from Adekeye (12) (0.9%) and Oji (6) (0.55%). Carroll et al. (4) found a much higher rate, with 7.37% of the studied population including children from 0 to 5 years of age. Likewise, Chrcanovic et al. (24) found a rate of 4.49% in children from 0 to 6 years of age, while Chrcanovic et al. (25) found a rate of 6.15% in children from 0 to 10 years of age. The peak incidence of facial fractures could be observed in the 13- to 18-year-old group, which, although the age groups may vary from study to study, is in agreement with findings from previously published works (9, 26). This statistic can be explained by increased activity, by more aggressive sports activities as well as by altercations in this age group. When children become adolescents, the incidence of maxillofacial trauma is similar to that in adults.

The relative lack of pneumatization of the paranasal sinuses, as well as the presence of a large tooth-bone ratio, tends to make the pediatric facial skeleton more elastic and stable. Moreover, the suture lines are flexible. Children also have larger fat pads that cushion the impact and lessen the force transmitted to the bone architecture (27, 28). In addition to these anatomical differences, the more protected environment of children, and the use of car seat restraints for infants and young children, may contribute to the lower frequency of pediatric facial trauma. The incidence of facial trauma is rare below age 5 (0.6–1.4%) (2, 4, 6, 12, 19, 29–31) and their incidence rises as children begin school (6, 28). As children grow, the frontal prominence diminishes and the mandible comes to occupy a position which is more vulnerable to traumatic injury. Furthermore, with maturation, the paranasal sinuses grow and pneumatize, rendering the midface more susceptible to fractures (32). More adult anatomical and social characteristics are adopted according to growth development (going out at night, interpersonal violence, the beginning of the working life, legal permission to drive cars and motorcycles after the 18 years of age, increased unsupervised physical activity and sports). As such, this age population becomes more prone to facial injuries (2, 3, 7, 12, 24, 33).

There are also some reasons that lead to undiagnosed, and thus untreated, fractures in children. Facial edema in the young child is quick and easily masks fractures. Furthermore, the facial bones are small and difficult to palpate. If radiographs are obtained, they are usually difficult to interpret due to the underdeveloped and poorly pneumatized sinuses, offering less contrast. The presence of developing teeth and tooth buds can also obscure the fracture line. Greenstick fractures are common, with minimal or no fracture displacement, or involve cartilaginous facial structures, making diagnoses more challenging (27).

Injured patients were more commonly boys than girls, resulting in a ratio of 3.38:1 (with facial fractures, Table 1; 3.10:1 for the entire sample), a similar result was found in earlier studies of facial fractures in children by Adekeye (12) (2.1:1), McGraw & Cole (32) (2:1), Bamjee et al. (26) (2.3:1), Oji (6) (2.64:1), Qudah and Bataineh (9) (2.34:1); Gassner et al. (10) (1.8:1), Chrcanovic et al. (24) (2.68:1), and Li and Li (11) (1.6:1). The reason for this proportion is that boys are generally more boisterous than girls and spend more time outdoors (7, 28, 34). In spite of this, gender revealed no statistically significant difference for the presence or absence or fractures ($P = .180$; Table 4).

The ratio of males to females varied considerably with each age and the overall distribution showed that the ratio of males to females in patients of 0–6 years of age was 1.85:1, whereas it was 3.18:1 for the group of 7–12 years of age and 4.23:1 for the group of 13–18 years of age (Table 1). A similar result occurred in the study of Shaikh and Worrall (15), but with different age groups: the ratio of males to females in patients of 1–10 years of age was 1.5:1, whereas the ratio of males to females in patients of 11–18 years of age was 7.6:1. The male to female ratio increased markedly throughout the older group. In the group of 16 to 18 years of age, this ratio was 12:1.

In the present study, there were a total of 566 facial fractures in the 464 patients, averaging 1.21 fractures per

patient. According to Gassner et al. (10), the frequency of 2 fractures per adult with bone fractures decreases in children to a frequency of 1.6 fractures per child. There is a 5-times reduced likelihood of facial bone fractures in pediatric facial trauma in comparison to adolescent and adult trauma (10).

The distribution of fractures in the day of the week showed a predominant distribution of accidents causing pediatric facial fractures at the weekends, particularly on Saturday and Sunday (37.5%). These data are in agreement with Eggensperger et al. (35). These are the days of great opportunity for outdoor and sports activities, short trips and recreation in general, thus tending to a higher chance of trauma.

Several studies (2, 12–18) found vehicles accidents to be the main etiological factor of fractures in children and adolescents, as can be confirmed in the present study (Table 3). Stylogianni et al. (14) attributed this data to the increase in traffic density as well as to the fact that children in Greece are not prohibited from sitting in the front seat and safety belts are not frequently used. According to Wood and Freer (36), maxillofacial injuries as a result of motor vehicle accidents are still relatively high regardless of the legislation for compulsory seatbelt use.

The proportion of patients with facial fracture after a fall (101 of 186–54.30%, Table 4) was statistically lower than all other causes ($P < 0.002$), except in the case of 'other' etiologies ($P = 0.26$). Thus, the 'fall' etiology could be considered to have the lowest morbidity. This finding correlates with the low mean age of patients who suffered maxillofacial trauma due to'falls' (Median age = 6.00) (Table 5). Rowe & Killey (19) believed that younger children are less active and lighter in weight and, therefore, fall less frequently and less forcefully, which may explain the lower incidence of fractures in children of less than 6 years of age.

Comparing the age of the patients to the etiology, it could be observed that the groups presented statistically different ages (Mann–Whitney test, $P < 0.001$), except when comparing the age between the groups 'fall' and 'others' (Mann–Whitney test, $P = 0.008$) and 'vehicles' e 'sports' (Mann–Whitney test, $P = 0.399$) (Table 5). The percentage of the various etiologies reported depends on the age groups examined and on the types of fractures included (*e.g.* children below 18 years of age vs those below 6 years of age; inclusion or exclusion of dentoalveolar and/or nasal fractures). While young children usually sustain injuries from low-velocity forces (e.g. falls), older children are more likely to be exposed to high-velocity forces (e.g. in road traffic accidents, sports-related trauma) (1). Motor vehicle accidents (MVA) are the leading cause of death in children after the perinatal period (37) and the incidence of MVA-related maxillofacial injuries increases with age (38). The present study also showed this, considering automobile and motorcycle accidents together (0–6 years of age, 10.81%; 7–12 years of age, 17.70%; 13–18 years of age, 20.94%; Table 3). Falls as an etiology decreased when age increased (0–6 years of age, 66.22%; 7–12 years of age, 23.01%; 13–18 years of age, 9.39%; Table 3). The mean age of patients who suffered maxillofacial fractures due to falls was lower (Table 5), most likely due to a higher level of self-control as the child grows older.

On the other hand, violence increased when age increased (0–6 years of age, 4.05%; 7–12 years of age, 7.97%; 13–18 years of age, 28.17%; Table 3), as did sports (0–6 years of age, 0.00%; 7–12 years of age, 5.31%; 13–18 years of age, 10.47%; Table 3), showing a higher median age (Table 5). As motor skills improve, sporting injuries become more common. In contrast to adults, interpersonal violence is a rare cause of facial fractures in children. These injuries occur more commonly in adolescents (4, 7, 26, 28).

It is interesting to note that the majority of other studies revealed that falls (3–11), bicycle accidents (24, 39) or interpersonal violence (26) were the main causes of facial injuries. This difference in the main etiology of facial fractures may reflect the age range of the children studied. More recent studies have included only children in their common leisure activities, while prior studies included children and adolescents, as did the present study. One exception is the study of Shaikh and Worrall (15), who also included children and adolescents in their study, which found falls to be the main etiologic factor (55.1%). These authors also found dog bite injuries to be the most common etiology in 7-year-old age band. Adolescents are more inclined to interpersonal violence, as they are reaching the adult age group (4, 7, 26, 28). This pattern has been attributed in several studies to the increased intake of alcohol in this group and the significantly higher incidence of assaults (7).

When comparing the number of fractures according to etiology, the groups showed no statistically different number of fractures, except when comparing the groups 'fall' and 'violence' ($P < 0.001$), 'fall' and 'vehicles' ($P < 0.001$), and 'fall' and 'sports' ($P = 0.001$).

In the statistical association between gender and etiology, the proportion of females attended to for falls (60 of 186–32.26%) was higher than the proportion of females attended to for violence and vehicle accidents (Table 6). The reason for this result is that girls are generally less boisterous and violent than boys at older ages (7, 28, 34), and drive more carefully than boys, thus tending to suffer fewer fractures due to less violence and fewer automobile accidents. Moreover, throughout the world, traffic accidents involve mainly young men (36, 40). The presence of falls, in contrast, may be nearly equal for both genders at younger ages, where there is little difference in physical activity among girls and boys.

The mandible was the most common fracture site in children (40.11%), followed by the nose (28.26%) and zygomatic complex (12.01%), which is in accordance with that found by McCoy et al. (29). Mandibular fractures are the most common facial fractures seen in hospitalized children (3, 4, 7, 9, 24, 28, 39). Their incidence increases with age (2, 28). The most common fracture region in the mandible was the condyle (16.25% of all facial fractures; Table 2), which is in agreement with other studies (4–6, 9, 14, 26, 39). Only Jaber and Porter (30) showed that mandibular fractures occurred at a significantly higher rate than those of the condylar region. A study from Finland (5) showed that the

proportion of condylar fractures decreased and the proportion of the body and angle increased with increasing age; thus, it seems that condylar fractures occur at a higher rate in children than in adults. Dentoalveolar and nasal fractures are both very common in children and are often treated in an outpatient setting. Kaban et al. (3), on the other hand, found the opposite, with the nose fracture being preponderant, and mandible fractures being the second most commonly fractured bone in children. Interestingly, Bamjee et al. (26) found a preponderance of mandibular fractures, and a rare occurrence of nasal fractures. This can most likely be explained by the lower incidence of falls in their study.

Seventeen (3.01%) fractures of the midface (FNOE + Le Fort types) were recorded in this study. This low percentage is in agreement with findings from other studies (3, 12, 13, 23, 26, 33). This may be attributed to the fact that the midface is the most protected area in children because of its retrusive position relative to the prominent calvaria, the high elasticity of children's bones, the smaller face relative to head size, and a decreased exposure to major trauma (3, 23). Midface fractures are generally injuries seen in older children and in the adult population. Above the age of 5 years, as the maxillary sinuses continue to expand and the permanent teeth erupt, the incidence of midface fractures increases (28, 33). The highest incidence occurs in children of 13–15 years of age (33). On the other hand, in the study of Gassner et al. (10), midface fractures accounted for 64.5%, while mandible fractures accounted for 35.5% of the cases.

The nasal bones are the least resistant of the facial skeleton. This, combined with the relative prominence of the nose, which increases with growth, makes it most likely area to sustain injury in older children (3). Conservative management of nasal fractures, consisting of the repositioning of the nasal bone, evacuation of the septal hematoma and repositioning of the septum in the midline with limited resection of septal bone and cartilage, should be undertaken. Radical nasal reconstruction in children is not commonly recommended and may in fact be harmful to the child's subsequent nasal function (13).

Because the facial bones of the child heal much more rapidly than do those of the adult, stabilization is required earlier, usually within 5 days. Unwarranted operative intervention in the child, including unnecessary internal fixation, inadequate treatment or the recognition of chondritis, hematoma or seroma, may lead to greater long-term deficits and deformities in children than in adults (41). While non-displaced fractures can be treated by observation, combined with a liquid to soft diet and analgesics as needed, displaced fractures often require closed or open reduction and fixation (4, 28, 32).

Other authors (6, 9, 16) have reported a smaller percentage of surgical treatment in their patients than in the present study (39.44%). This difference in the surgical treatment of facial fractures may reflect the age range of children studied. Prior studies generally only include children up to 15 years of age in their common leisure activities, whereas this study included children and adolescents up to 18 years of age. Ferreira et al. (17) treated only 25% of their patients conservatively, but their ages ranged from 1 to 18 years of age, with a peak incidence being between 16 and 18. Of the 101 patients with mandibular fractures, considering the patients of less than 16 years of age, 47 underwent an open reduction by Iida and Matsuya (39).

No statistically significant difference could be observed concerning the association between treatments in patients with fractures and gender ($P = 0.28$). However, the difference was statistically significant for the association between type of treatment and patient age ($P < 0.001$). The median age of patients with fractures was higher in those who underwent surgical treatment. Generally, the need for surgical intervention is more common in older children, which was also observed in findings from McGraw and Cole (32).

In our institution, we routinely use rigid internal fixation with plates and screws for treating facial fractures in adults. Open reduction and rigid internal fixation in the management of displaced fractures in children are also commonly performed. In the past, open reductions were generally avoided so that damage to the tooth buds would not occur. However, with the current availability of mini-plates and microplates, it is possible to perform open reduction and internal fixation without damaging the tooth buds in some instances (42). Because the majority of patients were 6–12 years of age or were older than 13 years of age, it can be assumed that the teeth were safely away from the inferior border. In these cases, microplates or miniplates were used to stabilize the fractures.

Conservative treatment of pediatric facial fractures has been the standard of care for many authors, owing to the high osteogenic potential of facial bones in children. Early healing of fractures occurs with a significant amount of subsequent remodeling under the influence of the forces of mastication (32). In addition, children in the deciduous and mixed dentition stages demonstrate some capacity for spontaneous occlusal readjustment, after injury and treatment, as deciduous teeth are shed and permanent teeth erupt (1).

The proportion of patients who had undergone conservative treatment was greater among those whose fracture was caused by a fall as compared with a vehicle accident ($P < 0.001$; Table 7). Maxillofacial traumas caused by falls are usually caused by low-impact/low-velocity forces. Facial fractures with vehicle accidents results from excessive head excursion and greater relative energy when impacting the surrounding surfaces (43), thus leading to a greater number of facial fractures, or fractures of greater displacement. The large displacement of the bone parties in fractures is one of the indications for reduction, either fixed or not, other than conservative treatment.

In the treatment of fractured jaws in children, two principles must be considered: a short period of fixation and early mobilization and training exercises. Mandibular fractures without displacement and malocclusion are managed by close observation, a liquid to soft diet, avoidance of physical activities and analgesics. Most condylar fractures are treated with observation or closed reduction and a short period of maxillo-mandibular

fixation (MMF). The maxilla and mandible of a child contain either unerupted teeth or a mixed dentition. This produces a more stable structure, requiring greater force to cause a fracture, and makes fixation more difficult via either internal means or by MMF. The deciduous teeth have short bulbous crowns and are poor abutments for wires or arch bars. This makes interdental immobilization more difficult in children than in adults. This is true for patients with deciduous or mixed dentition. The patients above 12 years of age have the same conditions as an adult for the placement of arch bars. When open reduction is performed, the drill holes must be inserted, preferably in the inferior portion of the mandible. When tooth buds within the mandible do not allow internal fixation with plates and screws, this can be achieved with a mandibular splint fixed to the teeth or by means of a splint with MMF. Highly displaced fractures are usually treated by open reduction, regardless of the age of the patient.

Because of the high osteogenic potential and rapid healing of the facial skeleton in children, 2–3 weeks is adequate for the MMF, vs 4–6 weeks in adults (6, 12, 13). Anatomically desirable reduction is difficult after 7 days and may be impossible after 14 days; therefore, early treatment is the key to the prevention of complications and undesirable results (29).

In our treatment center, we treat zygomatic complex fractures by open reduction and internal fixation only in comminuted fractures and in cases of esthetic and functional impairment. In a displaced nasal fracture, we carry out accurate anatomic reduction within 7 days. In most cases, anatomic realignment, hemostasis and fixation are achieved under general anesthesia by closed reduction.

The number of pediatric facial fractures may be underestimated. Pediatric facial fractures are sometimes not suspected or overlooked in the emergency room. The injuries are uncommon, thus the index of suspicion may be low. Sometimes the history of the accident is difficult to obtain from a child and the accompanying caretakers may not have witnessed the accident (1). Plain radiographs are less helpful than in adults, particularly in the midface region where poorly developed sinuses and tooth buds occupy space and obscure skeletal anatomic landmarks (44). Computed tomography scans greatly increase diagnostic accuracy and have become the standard of care for imaging pediatric maxillofacial trauma victims (28).

Preventive measures are geared to reducing the number of accidents and/or minimizing the severity of injuries. The incidence, severity and mortality of craniomaxillo-facial injuries in adults and children can be reduced significantly by using seat restraints (43). Public health professionals who inform parents and caregivers about proper restraint practices can use this information in their educational efforts. The potential for disfigurement associated with these maxillofacial injuries may resonate strongly with parents. In this light, the prevention of disfigurement may provide additional motivation for proper restraint (43). The airbag is also well-established as an effective means of preventing serious head and face injury (36). One study indicated that the combined use of air bags and seat belts resulted in the greatest decrease in the incidence of maxillofacial injuries, followed by air bags alone and seat belts alone (45).

To decrease the occurrence of injuries caused by falls, strategies should include awareness campaigns, parent's education about the mechanisms of falls, increased parental supervision during playing activities and legislative measures to ensure the safety of windows and balconies (8). In sports, the use of preventive measures is less frequent than in motor vehicles. Most children with head injuries in bicycle-related accidents were not wearing protective helmets at the time of injury (6, 34). The importance of preventive measures should be emphasized. Supervising adults, i.e. coaches, administrators, teachers and parents should be educated. Children should be encouraged to develop appropriate habits (e.g. wearing a helmet and a seat belt) at an early age (1).

Databases of pediatric trauma cases corroborate high-frequency categories of injury and verify the effectiveness of developed prevention programs. Outcome assessment of such databases in multidisciplinary morbidity and mortality conferences can lead to improved patient care and better educated health care providers (10).

The nature of a retrospective study inherently results in flaws, with problems manifested by the gaps in information and incomplete records. Furthermore, all data rely on the accuracy of the original examination and documentation. Hence, when items have been excluded from the initial examination or not recorded in the chart, the study is thereby compromised and limited.

We were unable to obtain adequate follow-up information for many of the patients and, therefore, are unable make statistical comparisons among groups regarding long-term complications or the effects of the different treatment methods. In addition, it is a well-known fact that growth disturbance is a difficult complication to evaluate.

Conclusions

1 The median age of patients with maxillofacial fractures was statistically superior to those without fracture.
2 There were more accidents causing facial fractures at the weekends.
3 There was a male preponderance among our cases. There was statistical association between gender and etiology; the proportion of women attended to for falls was higher than the proportion of women attended to for violence and for vehicle accidents.
4 The most common causes of facial fractures in this study were vehicle accidents (44.62%; bicycle, 26.08%; automobile, 14.66%; and motorcycle, 3.88%) and falls (21.77%). The 'fall' etiology showed the lowest morbidity. Age was associated with the etiology of fractures and the etiology was associated with the number of fractures.
5 Overall, the most common sites of facial fracture in children were the mandible (40.11%), nose (28.26%), zygomatic complex and arch (13.78%).

6 The majority of the pediatric patients with fractures did not require surgical treatment (60.56%). The option for surgical treatment increased with age. The proportion of patients who underwent conservative treatment was greater among those whose fracture was caused by a fall as compared with those caused by vehicle accidents and other causes;
7 There was no statistically significant difference in the association between the type of treatment in patients with fractures and gender.

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