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Associated injuries in pediatric patients with facial fractures in Portugal: Analysis of 1416 patients

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ABSTRACT

Background: The authors performed a retrospective study to clarify the occurrence, causes, severity and predictors of concomitant injuries in pediatric patients with facial fractures in Portugal.
Methods: The clinical records of children and adolescents (0–18 years) with facial fractures treated by the Department of Plastic, Reconstructive, and Aesthetic Surgery and of Maxillofacial Surgery of São João Hospital, in Porto, Portugal, over a period of 20 years (1993–2012) were reviewed.
Results: A total of 1416 patients with facial fractures were included in this study. Concomitant injuries were observed in 1015 (71.7%) patients. No significant associations were found between sex and concomitant injury. Head and neck injuries other than facial fractures occurred in 962 patients (67.7%), lower limb injuries in 122 (8.6%), upper limb injuries in 115 (8.1%), thoracic injuries in 89 (6.3%) and abdominal injuries in 47 (3.3%). Concomitant injuries occurred more frequently after motor vehicle accidents (car accident, motorcycle accident and car–pedestrian accident) compared with other etiologies ($p < 0.001$).
Conclusion: The incidence of these facial fractures and their concomitant injuries is very high in Portugal. It is necessary to continue with the implementation of control measures and educational programs for the population, so that the number and severity of accidents causing fractures and their associated injuries continue to decrease.

1. Introduction

Trauma is the leading cause of morbidity and mortality among children and an important part is related to craniofacial fractures (Haug and Foss, 2000; Ferreira et al., 2005).

Children are uniquely susceptible to craniofacial trauma because of their greater cranial mass to body ratio. However, fractures of the facial skeleton are infrequent in pediatric patients and only 1–15% of all facial fractures occur in this population (Haug and Foss, 2000; Ferreira et al., 2005). A number of reasons explain the decreased frequency of injuries which translate into facial fractures, when compared with the adult population: adult supervision, increased flexibility of the facial skeleton, non-pneumatized sinuses, relatively large fat pads, and unerupted, buttressing teeth (Gassner et al., 2004; Eggensperger Wymann et al., 2008; Alcalá-Galiano et al., 2008; Imahara et al., 2008; Hatef et al., 2009; Muñante-Cárdenas et al., 2010; Iatrou et al., 2010; Wheeler and Phillips, 2011; Singhal et al., 2013). Young children are less often involved in occupational or violence-related accidents that are typically the cause of adult facial fractures (Eggensperger Wymann et al., 2008; Singhal et al., 2013; Hoppe et al., 2014). Lower body weight and small size favors the inertia reduction, thus minimizing the impact forces when the child collides with objects (Haug and Foss, 2000; Muñante-Cárdenas et al., 2010). Thus, greater forces are necessary to produce a fracture. However, as children grow their social environment changes: they go to school, and they participate in sports and activities involving body contact that increase the risk of trauma. The facial skeleton acquires adult characteristics and it becomes more likely to suffer fractures (Ferreira et al., 2005;

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Imahara et al., 2008; Alcalá-Galiano et al., 2008; Hatef et al., 2009; Wheeler and Phillips, 2011; Nardis Ada et al., 2013).

The causes and incidence of facial fractures in children vary widely as a result of social, cultural and environmental factors, as reported in previous publications. Most publications report that the majority of these injuries are encountered in boys who are involved in motor vehicle accidents (Bamjee et al., 1996; Hogg et al., 2000; Olasoji et al., 2002; Kieser et al., 2002; Ferreira et al., 2005; Eggensperger Wymann et al., 2008; Imahara et al., 2008; Muñante-Cárdenas et al., 2010; Kim et al., 2012; Singhal et al., 2013; Nardis Ada et al., 2013; Hoppe et al., 2014).

Of concern in the pediatric population is the high frequency of concomitant injury (Gassner et al., 2004; Ferreira et al., 2005; Alcalá-Galiano et al., 2008; Karabekir et al., 2012; Hoppe et al., 2014). This predilection is most likely because of the anatomic differences between children and adults. At birth, the cranial to facial proportion is approximately 8:1, compared with that of an adult, in whom it is approximately 2:1. In very young children, the frontal protrusion of the cranium and the relative retrusion of the face generate a greater risk of skull fracture relative to facial fracture from blunt frontal trauma; the skull absorbs the full force of the initial impact, thus 'protecting' the face (Haug and Foss, 2000; Hatef et al., 2009; Wheeler and Phillips, 2011; Hoppe et al., 2014). Consequently concomitant cranial and intracranial and other head injuries may accompany facial fractures in children more frequently than in adults (Gassner et al., 2004). Furthermore because of the high-energy trauma mechanism generally involved, it can be assumed that associated injuries occur frequently in children who have sustained fractures of the facial skeleton.

Diagnosis of facial fractures and associated injuries in pediatric patients may be extremely challenging because of children's weak cooperative skills, particularly in the youngest (Iatrou et al., 2010). However, the associated injuries sustained may demand more rapid diagnosis and intervention than injuries to the facial bones and some of these could be fatal (Eggensperger Wymann et al., 2008; Imahara et al., 2008; Alcalá-Galiano et al., 2008; Karabekir et al., 2012; Hoppe et al., 2014).

Few studies with a high number of patients report the characteristics of these fractures in the pediatric population (Ferreira et al., 2005; Kim et al., 2012). Even fewer studies analyze in detail the characteristics of associated injuries (Thorén et al., 2012).

The purpose of this study was to provide a comprehensive overview regarding the associated injuries in pediatric patients with facial fractures in Portugal. An additional aim was to identify factors that predict the occurrence of concomitant injuries and if possible suggest the necessary actions to prevent them.

2. Materials and methods

2.1. Patients

Patients younger than 19 years of age with facial fractures, admitted at the Department of Plastic, Reconstructive, and Aesthetic Surgery and Maxillofacial Surgery of São João Hospital, in Porto, Portugal over a period of 20 years (1 January 1993, to 31 December 2012), were eligible for this study. Patients with isolated nasal and nasoethmoidal fractures, those treated only as outpatients (without an in-hospital stay), and those with inadequate clinical records were excluded. A total of 1416 patients were included.

The São João Hospital Ethical Commission approved the study.

2.2. Exposures/outcomes

The clinical records of all patients were reviewed for age; sex; cause of accident; year of hospital admission; location and type of fractures; presence and location of associated injuries; and length of in-hospital stay.

In regards to age, patients were divided into six groups; group 1: 0–3 years of age; group 2: 4–6 years; group 3: 7–9 years; group 4: 10–12 years; group 5: 13–15 years; and group 6: 16–18 years. The Portuguese population, in particular those aged 18 years or younger and from the area where the patients came from, was stable (in numbers) during the analyzed period.

Cause of injury was divided into six categories: 1) motor vehicle accidents, including car, motorbike, and car–pedestrian accidents; 2) bicycle accidents; 3) falls (from a height and at ground level); 4) sports; 5) violence; and 6) other accidents (work accidents, domestic accidents, and accidents with animals). The fractures were divided into five major groups: 1) single mandibular fractures; 2) multiple ($\geq$2) mandibular fractures; (3) single midfacial fractures; (4) multiple ($\geq$2) midfacial fractures; (5) combined mandibular and midfacial fractures.

Injured organ systems were classified as follows: 1) head and neck, including the face and cervical spine; 2) chest, including the thoracic spine and diaphragm; 3) abdomen, including the abdominal organs and lumbar spine; 4) upper limb; and 5) lower limb, including the pelvic skeleton. For each organ system, all of the different types of injuries were recorded in detail.

2.3. Statistical analysis

Categorical variables were summarized with absolute (n) and relative (%) frequencies and compared using the chi-square test. When differences were significant the Bonferroni method was applied for pairwise comparisons.

To assess mean differences in length of hospital stay and the number of concomitant injuries, estimated marginal means and their standard error were calculated using a general linear model accounting for confounding factors. The significant main effect of the number of concomitant injuries for each injured organ system on length of hospital stay was further analyzed using least significant difference post hoc tests.

Data were analyzed by SPSS version 21.0 and $p < 0.05$ was considered significant.

3. Results

Among the 1416 patients included in the study, 1069 (75.5%) were male and 347 (24.5%) were female (male:female ratio 3.1:1). The mean age (SD) was 12.9 $\pm$ 4.9 years. The youngest patient was a 4-month-old boy.

The patient distribution of this 20-year analysis is shown in Fig. 1. The number of patients decreased during the analyzed period with significant differences in the admission numbers in the different years ($p < 0.001$).

A total of 2071 facial fractures were registered. The most common cause of facial fractures was motor vehicle accidents (48.7%), mainly car accidents (24.2%). Although mandibular fractures were the most prevalent, with 920 fractures (44.4% of all fractures), the commonest facial fracture pattern was an isolated midfacial fracture (37.9%). The occurrence of fractures increased with increasing age group, from 5.4% in the 0 to 3-year-old group to 43.9% in the 16 to 18-year-old group (Table 1). Single fractures were present in 971 patients (68.6%), two fractures were seen in 314 patients (22.2%) and three or more fractures were seen in 131 patients (9.3%).

Table 2 presents associations between the occurrence of concomitant injury and sex, age group, trauma mechanism and type of facial fracture. A total of 1015 patients (71.7%) had concomitant injuries. No significant association was found between the sex of the patient and occurrence of concomitant injury.