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Paediatric maxillofacial trauma

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INTRODUCTION

Fractures of the facial skeleton are usually reported as infrequent in the paediatric age group, particularly among children who are younger than 12 years of age.

In our recent study (Bamjee, 1993; Bamjee *et al.*, 1996), the prevalence of maxillofacial injuries in a South African paediatric population was investigated. In an analysis of 4 192 facial trauma cases, approximately 8 per cent of patients were children under 18 years of age and fewer than 3 per cent were children 12 years of age or less. Several substantial reviews (Rowe, 1968; Hoof and Merkx, 1977; Adeykeye, 1980; Ellis *et al.*, 1985) of facial trauma have concurred with these low figures and have reported an incidence of facial fractures in children ranging from 3 to 14 per cent.

Despite the lower incidence of these injuries compared with that of the adult population, the impact of paediatric facial fractures can be more serious because the facial structures are still undergoing significant developmental changes and growth. Facial trauma in children may result in injury to the facial growth centres, leading to subsequent developmental abnormalities in the injured area. Facial hypoplasia and asymmetry, as well as impairment of normal function, can be the ultimate outcome of these injuries.

From the review of the studies done to date, certain points and special considerations give us a clear understanding of the patterns of paediatric maxillofacial trauma (Posnick, 1992).

In spite of the natural adventurous spirit and inherent lack of caution, children have a much lower incidence of facial bone fractures than adults. This apparent paradox may be explained, to a considerable extent, by theories based on environmental, anatomical and physiological circumstances and differences between the adult and paediatric craniofacial skeleton (Rowe, 1968; McGraw and Cole, 1990).

ENVIRONMENTAL FACTORS

Children are generally subjected to a more protected environment than adults and are therefore less likely to be exposed to traumatic injuries of a magnitude which could result in facial fractures. Infants and young children are protected by car-seat restraints, which could also contribute to a lower frequency of paediatric facial trauma. The small size and weight of a child results in less inertia when a child is thrown forward in a motor vehicle accident, which reduces the force of impact on the face in comparison to an adult. Also, children younger than school age do not participate in team sports and are less likely to be involved in fights with their elders.

The majority of paediatric facial trauma is secondary to motor vehicle accidents and other vehicular accidents such as tricycles and bicycles (Rowe, 1968; Smith, 1973; Hill *et al.*, 1984; Gussack *et al.*, 1987; Zachariades *et al.*, 1990). The main reason for the high occurrence (45 - 65 per cent) of motor vehicle accident related facial trauma in children and adult passengers is due to the lack of safety precautions (Perksin and Layton, 1988). Automobile-pedestrian accidents are another common but less frequent aetiology of facial trauma in young children, accounting for 25 per cent of injuries.

Assaults and accidental gunshot wounds to the face were the next most frequent cause of paediatric body injury (25 per cent — McGraw and Cole, 1990). In certain countries, e.g., United States, Norway, United Kingdom, North Africa and Southern Africa, assaults are the most frequent (60 per cent) cause of facial and body injury. This is mainly due to certain social-cultural and political behaviour patterns (Smith, 1973; Brook and Wood, 1983; Voss, 1982; Beaumont *et al.*, 1985).

The recent South African study on paediatric maxillofacial trauma (Bamjee, 1993; Bamjee *et al.*, 1996), showed that the patterns of cause varied by age. Accidental falls were the most frequent cause of facial injury in children of 12 years or less. In contrast, violence was particularly common among the teenage group. Vehicular accidents were less common among teenagers than younger children.

Within the category of assaults and gunshots, an interesting study by Martin and Gussack (1990), was undertaken to investigate penetrating head and neck trauma in children. Although this subtype of aetiology was uncommon, it is regarded as important in view of its potentially life threatening outcome. They reviewed 21 head and neck cases and found the injuries included vascular, cranial, ocular and severe maxillofacial types, which resulted in either permanent disability or death.

Other important causes include accidental fall, sports related injuries, birth canal trauma and child abuse. Thus far only few

cases of birth canal trauma resulting in maxillofacial injuries have been reported (Campbell, Moore and Hill, 1975; Taylor-Monks, 1977; Adeykeye, 1980; Stylogianni *et al.*, 1991). The commonest type of injury recorded in these studies was the fractured mandible.

Needleman (1986) studied orofacial trauma patterns in child abuse and found that trauma to the head and associated facial areas occurred in approximately 50 per cent of the cases. Soft tissue injuries and fractures were the common types of injury. Two of the most dramatic facial injuries seen in children were those of patients involved in the battered baby syndrome in which children had severe facial lacerations, skull fractures and fractured mandibles (Sanders, 1982).

ANATOMIC CONSIDERATIONS

Although environmental factors result in reduced exposure to potential causes of facial trauma, anatomic differences between the paediatric facial skeleton and that of the adult, may contribute to a lower prevalence of fractures (Fig. 1).

Two of the most important anatomic factors in the reduced frequency of facial fractures in children are the larger craniofacial ratio in the paediatric facial skeleton (Fig. 1) and the lack of pneumatization of the paranasal sinuses (Fig. 3) (Rowe, 1968; Sander, 1982; McGraw and Cole, 1990). This is explained as follows:

a. The face is relatively underdeveloped, and the surface area of the face is comparatively smaller than the cranium. In the infant, the maxillary antrum and zygoma are poorly developed and the mandible is relatively small and unobtrusive. In contrast, the frontal cranium is quite prominent (Fig. 1; Scott and Symons, 1977). The cranium and forehead effectively shield the smaller lower and middle thirds of the face from injury (Fig. 2).
b. The relative lack of pneumatization of the paranasal sinuses in children less than 10 years of age as a result of slow bone growth, adds to the stability of the midface. Hence this lack of development of maxillary, ethmoidal and sphenoidal sinuses contributes to the low prevalence of Le Fort II and III injuries (Fig. 3).

PHYSIOLOGICAL ASPECTS

With pneumatization of the paranasal sinuses and the growth and development of the permanent dentition, there is vertical and anterior growth of the maxilla and mandible. The facial growth results in a decrease in craniofacial ratio from 8:1 in infancy to 3:1 in adulthood (Fig. 1; Maniglia and Kline, 1983).

Correlated to the maturational growth patterns of the paediatric facial skeleton, the frequency of facial fractures increases with age during childhood. In particular, the proportional increased growth of the middle and lower facial thirds that occurs with maxillofacial development places these entities in a more prominent anterolateral position and allows them to become more susceptible to traumatic injury.

McGraw and Cole (1990), found supra-orbital rim and frontal skull fractures to be the most common facial fractures of children aged 0 to 6 years old, whereas mandibular fractures were more common in children older than 6 years of age. Fractures involving the inferior orbit, zygoma, and maxilla were almost exclusively found in children older than 10 years.

The presence of multiple developing tooth buds of both the deciduous and permanent dentition within the maxilla and mandible (Fig. 3), increase the elasticity and stability of the paediatric facial skeleton (Rowe, 1969). The multiple dental follicles within the mandible and maxilla help to maintain the fractured bone fragments in their normal or close to normal positions following injury.

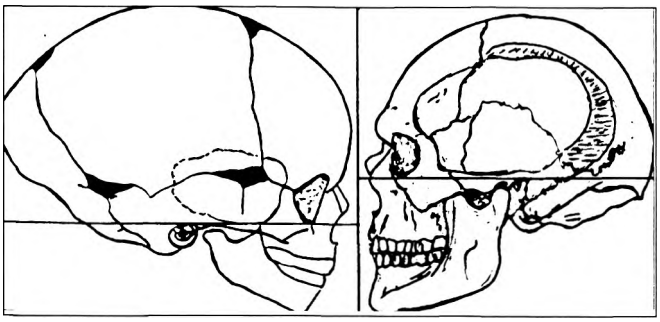


Fig. 1: **Skulls of new-born child and adult compared in lateral view. The skulls are orientated on the Frankfurt plane. Relative to the adult skull that of the child has been magnified twice in all dimensions (Scott and Symons, 1977).**

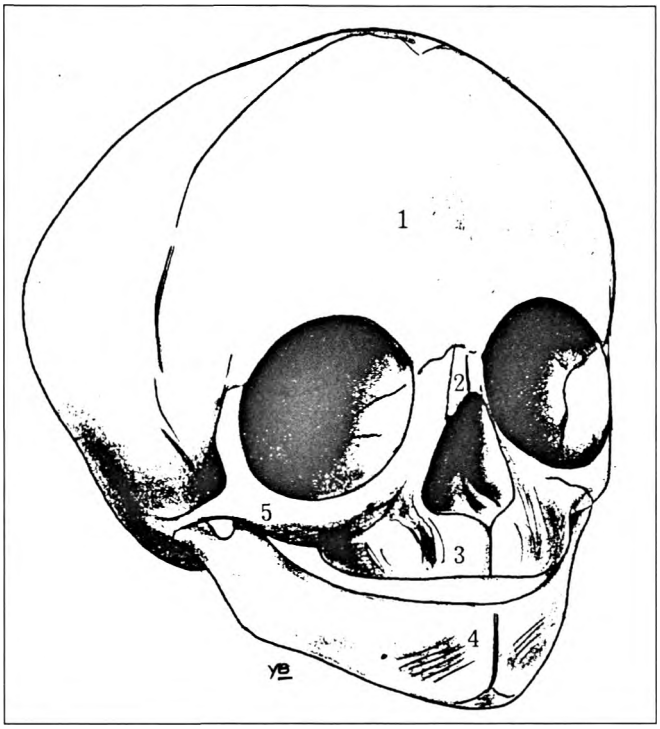


Fig. 2: **Anatomic features of the facial and cranial bones in an infant skull.**

Key: 1 Prominent Frontal Cranium
2 Small Nasal Bones
3 Underdeveloped Maxilla
4 Unobtrusive Mandible
5 Flat and Underdeveloped Zygoma

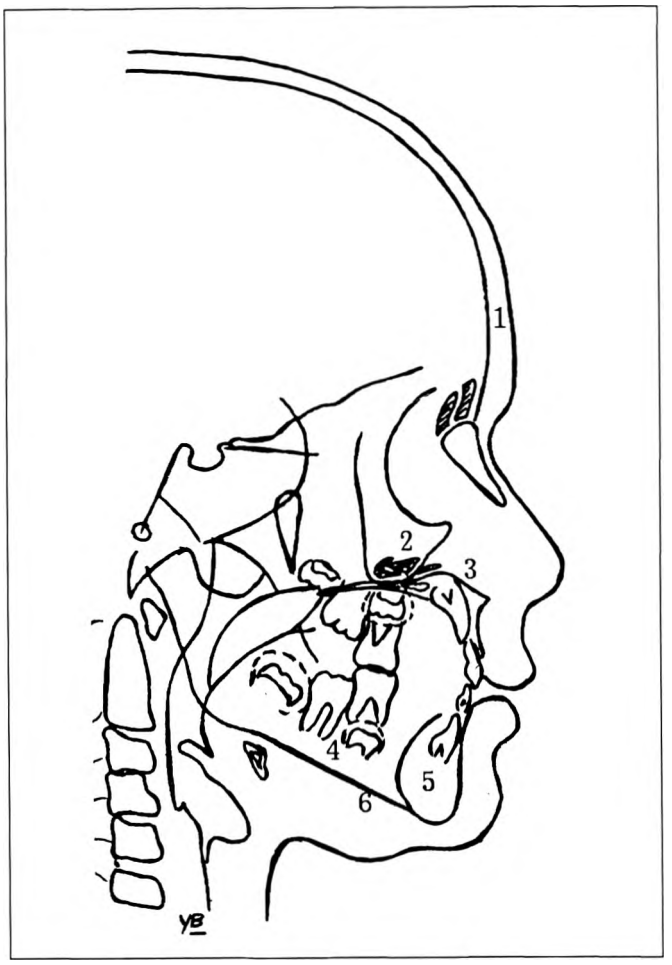


Fig. 3: **Important anatomic features of cranio-facial complex in a 5 year old patient.**

Key: 1 Prominent Frontal Cranium
2 Underdeveloped Paranasal Sinuses
3 Underdeveloped Zygoma and Maxilla
4 Multiple Developing Tooth Buds
5 Unobtrusive Mandible
6 Thin Cortical Bone

In addition, the cortex of the paediatric skeleton is very thin in comparison to that of the adult, with a greater proportion of spongy cancellous bone, so that facial bones are more elastic and resilient to injury. For these reasons, a higher frequency of greenstick fractures occurs, without disruption through both cortices and often without significant displacement of the fracture fragments. Children also have more prominent buccal fat pads that tend to cushion the impact of trauma and lessen forces transmitted to underlying bone.

Furthermore, the elasticity of young bone and the large number of resilient growth centres permit a greater degree of distortion to occur before fracture, and these factors in conjunction with the lower momentum of a smaller body mass, will often maintain the integrity of the facial contour, whereas in adults there would be severe displacement.

There are two other points related to both the pattern of fractures and to the healing of paediatric fractures for consideration, namely: the high osteogenic potential of the periosteum, and the pronounced vascularity with a high rate of growth activity of certain facial skeletal components, e.g., the condyle and the nose, particularly during the first two years of life. This leads to early union associated with a high degree of modelling resorption, subsequently resulting in functional and aesthetic complications (Polayes, 1989).

In general, in earlier studies the age distribution of the groups examined was incompletely reported, in that no uniform age range or age grouping was specified (Rowe, 1968; Keniry, 1971; Hall, 1974; Reil and Kranz, 1976; Fortunato *et al.*, 1982). Recent investigations by Gussack *et al.*, (1987); McGraw and Cole (1990) and Stylogianni *et al.*, (1991) exemplify proper age grouping, which is useful for standardization of occurrence and distribution of types of injuries. Age groups were established on the basis of facial skeletal and dental growth. Three age groupings were recommended, namely: group 1 consisted of patients age 0 through 6 years; group 2, patients aged 6 years through 12 years; and group 3 patients aged 12 years through 18 years.

Most studies (Rowe, 1968; Hall, 1974; Gussack *et al.*, 1987; Zachariades *et al.*, 1990; Stylogianni *et al.*, 1991), have shown that traumatic injuries to the face occur most frequently between the ages of 7 to 14 years. In comparison, the trend in South Africa differed to the overseas studies and it was found that the majority of maxillofacial injuries occurred in the 12 to 18 year age band (Bamjee, 1993; Bamjee *et al.*, 1996).

The majority of the major studies (Rowe, 1968; Adeykeye, 1980; Ellis *et al.*, 1985) show that males suffer facial injuries three times more often than females. This is the same trend as evidenced by our study in South Africa (Bamjee, 1993; Bamjee *et al.*, 1996).

INJURY TYPES

Most past and existing studies show a high occurrence (70 per cent) of injuries to the lower face, with the nose being most affected (Lundin *et al.*, 1973) followed by injuries of the mandible (Rowe, 1968; Gussack *et al.*, 1987; McGraw and Cole, 1990). Unfortunately most paediatric surveys exclude nasal fractures, which then makes mandibular fractures the most common of pure maxillofacial injury treated by maxillofacial surgeons. Finally dento-alveolar fractures were also reported as frequent injuries specially in children older than 10 years.

Recent studies by Gussack *et al.*, (1987) and McGraw and Cole (1990) have also reported high percentages (22 - 36 per cent) of fronto-orbital injuries in paediatric patients. This is because the cranium-forehead is very prominent in children as compared to adults.

Associated injuries occur more frequently in children with maxillofacial trauma, especially multiple associated injuries (Rowe, 1968; Gussack *et al.*, 1987; McGraw and Cole, 1990). McGraw and Cole (1990) showed that 88 per cent of all patients had associated injuries occurring with facial fractures, of which 61 per cent were of the multiple type. Skull

fractures and intra-cranial injuries were particularly more common in children, due to the high craniofacial ratio in children as well as to the elasticity and stability of the facial skeleton. Orthopaedic injuries of the limbs also frequently occur in association with paediatric facial fracture, with concommitant cervical fractures occurring to a lesser extent. A recent study by Hayter, Ward and Smith (1991) showed that in 153 patients who sustained severe body injuries, 35 per cent had severe maxillofacial injuries. Seventy per cent of these occurred in the infant to 30 year-old group.

The injury types of paediatric patients in our studies (Bamjee, 1993; Bamjee *et al.*, 1996) showed that mandibular body fractures and maxillary dento-alveolar fractures were most common. Soft tissue injuries were far and away the most frequently occurring associated injury followed by cranial and orthopaedic injuries.

CONCLUSION

Differences in the pattern of maxillofacial fractures between children and adults must be recognized to provide for appropriate diagnosis and treatment. Thus, the goal of management of paediatric facial fractures is preservation of function and facial symmetry. A systematic approach is essential to avoid additional injury from iatrogenic trauma. This would include a comprehensive examination, application of the special factors mentioned in this article, correct evaluation and diagnosis and finally a practical treatment format.

Facial fractures in children may go unrecognized as a result of lack of understanding of the reviewed special factors, incomplete communication, inadequate evaluation or late presentation of the injury. Fortunately, complications arising from paediatric facial fractures are few, despite the potential for injury to multiple growth centres. From the foregoing discussion it is clear that the scope of paediatric maxillofacial trauma is very dynamic and that ongoing research would maximize the functional, psychologic and aesthetic results for both patient and family.

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