Pediatric Craniofacial Injuries: Concept of Treatment

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Abstract

Pediatric craniofacial trauma is one of the leading factors of morbidity and mortality. Significant advances in management have been made through the last three decades. The objective of this study was directed to study the pattern of pediatric craniofacial fracture according to child age. Retrospective study was done on 18 pediatric cases treated at the last two years at the Department of Neurosurgery and Maxillofacial Surgery Shebin Al-Kom Teaching Hospital. The age of the cases ranged from six months to 14 years with mean age 7-6 years. Road traffic accident was the cause in 13 cases while fall from height was the cause in five cases. After complete evaluation clinically and radiographically with necessary consultation, the cases were treated under general anesthesia by both maxillofacial and neurosurgeon in almost all of the cases. The post-operative course was uneventful except in one case, a second surgery was needed for removal of the micro plates which was missed for two years and local arrest of growth happened. The pediatric craniofacial skeleton is unique from that of the adult in different aspects. The pattern of fractures changes according the stage of the child growth and it has a good reflection on method of treatment.

Key Words: Pediatric – Craniofacial – Trauma.

Introduction

MANAGEMENT of pediatric craniofacial injuries has evolved gradually over the past century. During the World War II. Waldron et al., were the first to recognize the unique nature of craniofacial injuries in the pediatric cases [1]. Before the past two decades, most surgeons advocated the conservative approach for the treatment of craniofacial injuries in children [2-10]. But at recent years and after inadequate treatment provided in some cases by conservative methods, many surgeons all over the world developed novel approaches for the management of craniofacial trauma including accurate preoperative diagnosis supplemented with CT scanning, direct wide exposure of all fractures, open reduction and internal fixation by using plates and autogenous bone graft when indicated [5,6,11-13]. Pediatric craniofacial injuries are less common in comparison with adults as regards, to the anatomical, social and environmental aspects [14]. At the first three year of life the frontal lobe of the brain is growing rapidly with associated prominence of the cranial forehead and orbit. Moreover there are no well-developed Para nasal sinuses and teeth. These factors contribute to the lack of anterior projection of the maxilla and mandible, and at the same time the superior orbital rim and frontal regions are relatively over projected Fig. (1). These anatomical variation makes the upper face and cranium more vulnerable to traumatic injuries in contrary to the excellent bone remodeling capacity which keep the incidence of complications very rare [15]. The use of bone plates in management of pediatric craniofacial cases younger than five years old may lead to local growth disturbances. In addition the child is subjected to another operation for plate removal to avoid this complication. The use of resorbable plates now day act as ideal solution for avoiding the second operation [16,20]. Pediatric craniofacial trauma is one of the leading factor of morbidity and mortality due to serious organ trauma. So careful attention must be directed to the hemodynamic stability of the child, as the circulating blood volume ranges from 90-70ml/kg and the allowance of blood loss should never exceed 20% of the estimated blood volume which usually is less than one fifth of adult blood volume [17].

The lack of mineralization (increase of cancellous to cortical ratio) in pediatric craniofacial skeleton, the incomplete development of sinuses and the presence of un erupted teeth are the cause of different fracture pattern which usually change by aging of bone growth [18].
Fig. (1): The skull to face ratio are changed from 8:1 at birth, 4:1 at five years to 2:1 at adult (16).

Collaboration is usually arranged between the team work according the extent of craniofacial trauma and mainly depend on the Maxillofacial surgeons, Neurosurgeons, Pediatrician and Ophthalmic surgeon.

The research was aimed to study the pattern of pediatric craniofacial injury and the concept of treatment as compared with adult.

**Material and Methods**

Retrospective study was done on eighteen children (10Ms & 8Fs) with sustained craniofacial trauma and admitted to both Neurosurgery and Maxillofacial Surgery Departments Shebin Al-Kom Teaching Hospital through the last two years (30/6/2012-1/7/2014). The age of the cases ranged from 6 months to 14 years with mean age 7-6 years.

Clinical examination and laboratory investigations were done for every child since admission to the Emergency Department; Pediatrician was attending from the beginning for general checkup and management of fluid replacement if necessary. CT scans with low dose and fine cuts was used as sole diagnostic modality for each child for demonstration of how far the fracture extended (Fig. 2).

Priority was directed for early neurosurgical interference in case of primary brain injury.

After complete recovery from the emergency status the patients had been arranged for treatment policy in this study by early management of fracture indicated for open reduction and fixation by using micro plates, miniscrews and meshes, further selective criteria was applied in this study and included.

- Cases with polytrauma indicated for urgent surgery by many specialists and possibility of postpone of craniofacial interference were exempted from the study.
- Cases with systemic diseases were not included in this study.
- Cases with trauma restricted to cranium and middle face were selected.

**Concept of management:**

I- The different patterns of craniofacial fractures were documented for each child.

II- Adequate explanation was provided for the parents of each child about the nature of the trauma and both primary surgery for treatment and secondary surgery for plate removal and photographing the patient, thereafter medical consent was taken.

III- The dose of indicated drugs and parenteral fluids before and after surgery were guided by pediatrician.

IV- All patients were treated under general anesthesia at the first week post admission except in three cases in whom the early interference for evacuation of intracranial hematoma postponed the craniofacial repair to the next week.

V- The surgical exposure was done by using the coronal or traumatic wounds and other approaches according the site of trauma. The approach exposure should include all fracture sites at the cranium and face Fig. (3).

VI- Dural tears associated with CSF rhinorrhea were documented in three cases and the repair was done first followed by reduction of displaced bone segments and internal fixation by using micro plates and screws as well as titanium mesh Fig. (5).

VII- Orbital fractures were surgically treated and reconstructed by using bone graft harvested from the outer cortex of the retro molar area Fig. (4).

VIII- Follow-up was extended for six months until the time of plate removal arrangement and done through the outpatient clinic of both Maxillofacial and Neurosurgery.

IX- All cases were arranged for secondary surgery for plates and meshes removal after six months.
Results

Road traffic accident was the main cause of craniofacial injuries in 13 cases while fall from height was present in five cases.

All patients were going well through the course of follow-up and plates and meshes were removed after six months of first surgery except in one case removal of the plate was missed by the patient family for two years and secondary arrest of local skull growth happened and the micro plates used in treatment were completely covered by healing bone Fig. (8-B). Dural injuries were repaired in three cases followed by reduction and fixation by miniplates and meshes Fig. (5-B).

Cranialization was done in fourteen years old child due to comminuted fractures of both tables of the frontal sinus which indicated the debridement of fragmented bones, removal of the sinus mucosa and closing the fronto nasal opening and then brain allowed to expand and occupy the sinus cavity (Fig. 7-C).

The patterns of pediatric craniofacial fractures were differed according the stage of craniofacial growth.
Fig. (4A-D): (A) Six months female child sustained orbital fracture. (B) Coronal CT scan. (C,D) Intra operative orbital reconstruction by bone graft harvested from the mandible.

Fig. (5A-E): (A) Craniofacial fracture in four years child including the skull base, orbit. (B,C) Intra operative dural repair associated with plate and mesh fixation dural. (D,E) Six months postoperative.
Fig. (6A-D): (A,B) Orbital and NOE with traumatic telecanthus are noticed in 9 years old child. (C,D) Two month's post-operative.

Fig. (7A-D): (A) Old child (14 years old). (B) Sustained localized fracture on both tables of frontal sinus. (C) Treated by cranialization after obliteration of the naso frontal duct opening. (D) The outer table was reconstructed by titanium mesh.
Fig. (9A-D): (A,B) Eight years old female child presented with craniofacial fractures. (C,D) Six months post-surgery.

Table (1): Distribution of cases according to age and related fracture pattern.

<table>
<thead>
<tr>
<th>Age</th>
<th>Number</th>
<th>Fracture pattern</th>
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<tbody>
<tr>
<td>6 months - 5 years</td>
<td>6</td>
<td>• The fracture radiate from the site of impacted force on the cranium horizontally to the orbit and vertically to the vault of the skull Figs. (2,3).</td>
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<tr>
<td></td>
<td></td>
<td>• Trauma directed to the middle face leading to local trauma at the impact of force usually the orbit Fig. (4).</td>
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<tr>
<td>6 years - 10 years</td>
<td>11</td>
<td>• Trauma tend to be localized due to developmental and physiological changes of sinus airition NOE (Naso Orbito Ethmoidal), orbital floor and maxillary fractures Fig. (6).</td>
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<tr>
<td>11 year - 14 years</td>
<td>1</td>
<td>• As the frontal sinus is developed and aerated trauma to the cranium is becoming localized without extension to other bones Figs. (7,9).</td>
</tr>
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</table>
Discussion

The pediatric craniofacial skeleton is unique from that of the adult in different aspects, the large cranium and small face with ratio 8:1 at birth decreased to 4:1 at the age of five and 2:1 at the adulthood (Fig. 1). The upper face grows forward secondary to the rapid growth of the brain [16]. The ocular development associated with orbital bone growth are completed by the age 6-8 years. The sinuses of the infant are underdeveloped and poorly pneumatized, the unerupted deciduous teeth, the abundance of buccomaxillary fat pad volume all of these factors increase the resistance of facial bone to any impacted traumatic force but in contrary the over projected cranium is more vulnerable to injuries than the face [1,5,10,12,19]. In this study the pediatric anatomical character was impacted on the fracture pattern and it usually radiate horizontally and vertically to fracture the skull and orbital bones in six cases of cranial trauma in children below five year of age (Table 1). As the age of our cases is increased and sinus aeration developed the fracture tend to be localized to the site of impacted, trauma. Our results are in agreement with the study reports of Denny et al., [21] and Ghali et al., [20]. Conservative management of pediatric craniofacial fractures was advocated by many authors since long time depending on the capacity of bone remodeling during healing, but in severe cases conservative management were not enough and the absence of suitable plates obliged the surgeons to continue the non-surgical management [2,4-6]. The recent advent of titanium micro plates through the last two decades improved the surgical management of craniofacial fractures by using the micro plate fixation after reduction of fracture. In the present study we selected the cases indicated for open reduction and internal fixation and we noticed the low incidence of the cases indicated for conservative treatment in comparison to that indicated for open reduction. Recently the new generation of resorbable plates restricted of the use of metallic hardware in children which avoid the second operation that usually have the same morbidity and mortality of the first operation. Our aim is to replace it by resorbable plates [20,21,23]. The use of bone graft in this study for pediatric orbital reconstruction is strongly indicated in age; below seven years as the orbital growth extend to the age of eight years and any metallic reconstruction may lead to arrest of orbital growth, this precaution was reported by Manson [19] and Ghali et al., [20].

Conclusion:

Pediatric craniofacial fractures are anatomically distinct from their adult counterparts and must be managed with respect to future growth and development. Almost all of cases who sustained frontal orbital trauma are indicated for careful evaluation and management of this kind of trauma for maintaining the vital function of the brain and the visual system. Further attention should be directed to associated Naso Ethmoidal Fractures as the residual deformities are difficult to be treated. Removal of the hardware after six months is mandatory to avoid the local skull deformity.

References


