Epidemiologic Analysis of Pediatric Maxillofacial Trauma and Review of the Literature

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March 30, 2022

Abstract

Background: The aim of the study is to make epidemiologic analysis of pediatric maxillafacial traumas and discuss the mechanisms of injury, etiology, treatment approaches and complications by comparing with adult maxillofacial traumas. Method: Pediatric maxillofacial trauma patients who presented to the Department of Plastic, Reconstructive and Aesthetic Surgery at our hospital, for 5 years between 2014 and 2018 were evaluated retrospectively. Age and gender distributions of the patients were determined. Duration of hospitalization, etiology of trauma, location of the fracture, and treatment methods applied were determined, and the results of these treatments and complications that developed were evaluated. Results: The fractures were the most common at the age of 17 years (17.2%). The most common cause of trauma in patients operated for maxillofacial trauma was fall (48.3%). Most operations were performed in the age range of 12–18 years (49.4%), and panfacial fractures were the most frequently operated fracture localization (27.58%). Conclusion: The simplest and most effective treatment should be applied for pediatric maxillofacial trauma. While conservative treatments may be sufficient in minimally displaced fractures, open reduction and internal fixation methods are applied in fractures with greater displacement. Fixation materials must necessarily be removed since they prevent bone growth. The use of bioabsorbable plates has been limited in recent years due to their high costs.

INTRODUCTION

Pediatric maxillofacial traumas are usually limited to soft tissue. However, compared to adults, facial bone fractures are rarely encountered in children. This is because the facial bones in children are less calcified than in adults, the maxillofacial region has a smaller size than the skull, and young children are especially better protected against trauma than adults. Since the maxillofacial sinuses are not aerated and the facial fat pads are more abundant in children, these patients require more severe trauma exposure than adults for maxillofacial fractures to occur [1-6]. The aim of the study is to make epidemiologic analysis of pediatric maxillafacial traumas and discuss the mechanisms of injury, etiology, treatment approaches and complications by comparing with adult maxillofacial traumas.

MATERIALS AND METHOD

This study followed the Declaration of Helsinki on medical protocol and ethics and the regional Ethical Review Board approved the study. In the study, 87 patients in the pediatric age group who were operated for facial bone fractures due to maxillofacial trauma Department of Plastic, Reconstructive and Aesthetic Surgery at our university between 2014 and 2018 were retrospectively reviewed. Patients under the age of 18 years with orbital, zygoma, maxilla, and mandibular fractures were included in the study. Three-dimensional maxillofacial computed tomography was performed for all patients. Then, patients were retrospectively evaluated according to age, gender, type of injury, location and number of fractures, administered treatments, intensive care hospitalization, and complications. Follow-up period ranged from 6 months to 3 years. Evaluation results were analyzed with SPSS 16.0 (SPSS Inc., Chicago, IL, USA)

RESULTS

A total of 65 males (74.7%) and 22 females (25.3%), totaling to 87 patients, were included in the study. The mean age of the patients was 10.78 years (Table 1), and the youngest patient operated was 6-months old. The fractures were most common at the age of 17 years (17.2%), and the most common cause at this age was motorcycle accidents (37.5%). It was observed that the most common cause of trauma in patients operated with maxillofacial fracture in our clinic was fall in both genders (48.3%), the second most common cause was motorcycle accident in boys (21.5%), and non-vehicle traffic accidents in girls (13.6%) (Table 2). When we classified the ages as 0–5, 6–12 and 12–18 years, the group that was most commonly operated due to facial fractures was between 12- and 18-years old (49.4%); the second most commonly operated age group was between 6- and 12-years old (26.4%); and the least commonly operated group was between 0 and 5-years old (24.1%).

In our clinic, the most commonly operated fracture localization was classified as panfacial fractures (fractures on at least 3 different locations) in 24 patients (27.58%), and the second most common localization was unilateral condylar fracture accompanied by symphysis or parasymphysis fracture (11.49%) in 10 patients, and unilateral corpus fracture accompanied by a ramus or angulus fracture in 10 patients (11.49%) (Table 3). Overall, mandibular fractures were the most common fractures (54 patients, 62%).

The length of hospital stay of the patients ranged from 1 day to 90 days. 11.5% of the patients were followed up in intensive care in the preoperative or postoperative period.

Operations were most commonly performed as open reduction internal fixation (35.6%) and arch bar application with open reduction internal fixation (25.3%). Other patients were operated using methods such as closed reduction of zygoma, orbital floor repair (with autogenous or alloplastic material), gap arthroplasty, intermaxillary fixation screw, and intermaxillary fixation (Table 4). In the postoperative follow-up of the patients, complications such as hematoma, bleeding, plate-screw exposition, displacement of the arch bar, and suture separation were observed.

DISCUSSION

According to a study performed by Grunwaldt et al. in 772 pediatric patients, the age range of 0–5 years is the age group in which facial fractures are the least common [7]. This is because they are under adult supervision, and fractures in this age group are due to daily activities. Children between the ages of 6 and 11 are the second group in which fractures are most common, and maxillofacial fractures generally result from motor vehicle accidents, games, and bicycle accidents in this age group. The age group of 12–18 years is the group in which facial fractures are most commonly detected in pediatric patients due to starting to drive cars, participation in sports activities and involvement in incidents of violence are often encountered in this age group [7, 8].

In the present study, 22 of 87 children were girls (25.3%) and 65 of them were boys (74.7%). When the patients were divided into 3 different groups according to the same age ranges, the most commonly operated patient group was the age group of 12–18 years (49.4%), and the least commonly operated group was the age group of 0–5 years (24.1%). These results are similar to those seen in the study by Grundwalt et al. In addition, the most common cause of fracture of the facial bones in these patients was falls, which is consistent with the literature.

It is difficult to perform an optimal examination in pediatric patients, especially because of lack of patient cooperation and communication at young ages. For this reason, imaging methods are important in the evaluation of fractures and computed tomography is usually used. Following an appropriate physical examination and stabilization of the patient, it is performed by taking into account intracranial and cervical spinal injuries, cranial bone fractures, soft tissue incisions and abrasions, as well as body and extremity injuries. In this age group, CT examination should be requested at the slightest suspicion of a fracture [8, 9]. Unlike adults, cranial and cervical spinal injuries are rare in this age group. In a study conducted by Xun et al., 2966 pediatric patients with craniomaxillofacial trauma have been examined and accompanying

cervical spinal damage has been detected in only 5 of them (0.169%), and the rarity of this condition in this age group compared to adults has been associated with anatomical differences [10]. We did not find any cervical spinal nerve damage in our patient group.

Considering the rapid healing of the facial skeleton, mostly conservative approaches are recommended in the literature for orbital and zygomatic fractures in children. In non-displaced or minimally displaced fractures, conservative treatment and follow-up is sufficient without surgical treatment. In the displaced, early fractures, closed reduction alone can be sufficient [11, 12]. We treated 2 of our patients with closed reduction alone at this site. Patients with complete dissociation were treated with similar principles in adult age. In zygomatico-orbital fractures, open reduction, and internal fixation should be applied if diplopia and/or endophthalmitis is seen or if there is orbital wall changes [9]. Orbital trapdoor fractures are orbital floor fractures that limit eye movements, lead to diplopia, and are characterized by herniation and compression of orbital contents. Early treatment is often recommended in these fractures. According to a study conducted by Gerbino et al., in the long-term follow-up of 24 patients operated for diplopia, residual diplopia has been detected in only 1 of 12 (8.3%) patients operated within the first 24 hours, and residual diplopia has been detected in 4 of 4 (100%) patients operated after 96 hours and later [13]. According to the results of this study, they have suggested that pediatric orbital trapdoor fractures are a surgical emergency that should be operated within the first 24 hours. Our approach to these fractures is to treat them as soon as the general condition of the patient allows. Since recovery is rapid in children, repair is recommended to be performed within the first 4 days [9]. It should be kept in mind that late repairs, especially in the zygomatico-orbital region, may result in reduced treatment success and make recovery more difficult. In the reconstruction of the orbital floor fractures, non-resorbable alloplastic materials such as porous polyethylene, titanium mesh, polyester urethane or resorbable alloplastic materials such as poly-L-lactide are used as well as autogenous tissues [14-17]. Because porous polyethylene implant (Medpor) is durable, it is used very often in orbital reconstruction. However, complications including inflammation, infection, cyst and abscess have been widely reported in the long-term [18-20]. Although titanium mesh has advantages such as high biocompatibility and easy shaping, complications including orbital adhesion, limitation in eye movements, and diplopia have been reported [21-23]. We used autogenous cartilage graft in 2 of the 4 patients that we operated due to orbital floor fracture, and we used a porous polyethylene implant in 2 of them. Residual diplopia was observed in 1 patient and ectropion, which improved following massage was found in 1 patient.

In order to avoid bone development problems in the future, it is important to make minimal intervention to the periosteum and muscle adhesions while treating fractures of the facial bones in children. Approaches in which fractures can be reduced and stabilized with minimal dissection should be adopted as a basic principle [11, 24]. If rigid fixation has been applied in pediatric patients, the issue of removing plate screws is very controversial. In some publications, plate screws have been reported to cause regional growth restriction and removal is therefore needed, while in other publications it has been reported that removal would be unnecessary [11, 12, 24, 25]. Haug et al. have reported that microplates can be used in periorbital fractures and that the growth of periorbital region ceases after 2 years of age and the microplates used in this region do not need to be removed [24]. We use microplates in zygomatico-orbital fractures and do not remove the plates. In maxilla and mandible fractures, we performed secondary surgery for removal of the plates.

The maxilla is the least commonly injured bone in pediatric facial traumas [26]. Due to greater flexibility of the facial bones, immature sinuses and differences in teeth and tooth development, pediatric maxilla fractures are not similar to classical LeFort fracture types as in adults [27]. Treatment of maxilla fractures is based on two basic requirements. The first is to avoid damaging bone growth, and the second is to achieve a sufficiently stable fixation. During patient evaluation prior to treatment, life-threatening conditions are addressed with priority, as in any trauma. Airway, breathing, and circulation are evaluated. Head, neck, cervical spine, and soft tissues are examined. Bleeding control and intervention are performed. Greenstick fractures of the maxilla are more common in children, and a good recovery can be achieved with a conservative approach [27]. In the treatment of minimally displaced fractures, 2-3 weeks of closed reduction with maxillomandibular fixation is sufficient. Ivy loop is used to ensure occlusion. Semirigid fixation should be applied in displaced fractures [11, 28, 29]. We performed closed reduction with ivy loop or arch bar in minimally displaced

maxilla fractures, and open reduction internal fixation with titanium microplates in displaced fractures. We performed the operations with as little dissection as possible, using minimal plate screws and trying not to damage the teeth. Since ivy loop and arch bar applications damage the teeth and gums, we have been recently performing intermaxillary fixation by placing a bracket system in older children.

Mandibular fractures are the most common fractures in pediatric facial traumas [30, 31]. Fracture was detected in at least one mandibular region in 54 of 87 patients treated in our clinic (panfacial fractures were evaluated independently from this group). The most common location for fracture of the mandible is condyle in children. In our series, 24 of 54 patients with mandibular fractures have at least one fracture in condylar area (27.5% of all fractures). Children under the age of 3 with condylar trauma are at high risk of joint ankylosis. Inadequate treatment in condylar fractures can cause growth restriction, while excessive immobilization may lead to mandibular hypomobility [32]. Open reduction should be performed if occlusion cannot be achieved due to the fractured condylar segment, the condylar segment has been displaced toward the middle cranial fossa, or in the presence of a foreign body. Conservative approach may be applied in greenstick and minimally displaced fractures [33-36]. In addition, if the fracture is intracapsular, our approach is observation, soft diet and physical therapy. In the greenstick and minimally displaced fractures of the mandibular angulus, body, ramus and symphysis regions other than the condyle , we recommend observation and soft diet as in the basic approaches. We use monocortical rigid fixation in displaced fractures.

In recent years, bioabsorbable plates made of polyglycolic acid and polylactic acid have been used in pediatric patients. These plates are preferred to prevent growth restriction in the facial bones, and because there is no need for a second surgery to remove them [24]. In a study by Eppley, it is reported that fixation with a 1.5 mm bioabsorbable plate and at least 2 screws can be sufficient for stabilization in mandibular fractures. However, the difficulties in shaping bioabsorbable plates and their lower resistance make it difficult to use them in mandibular fractures. In zygomatic and orbital fractures, the large size of bioabsorbable plates makes it more difficult to use them [37]. Another factor that prevents the use of bioabsorbable plates is their high cost. The total cost of a single bioabsorbable plate (450 USD/piece) and 2 bioabsorbable screws (125 USD/piece) is 700 USD for a simple mandibular fracture. The approximate cost of a titanium plate (30 USD/piece) and 2 titanium screws (10 USD/piece) that can be used in the same type of fracture is 50 USD. We prefer titanium plates due to the high cost of bioabsorbable plates and we perform second surgery to remove the plates.

In conclusion, pediatric maxillofacial traumas are less common than in adults. In this patient group, the primary treatment approach is conservative, and if surgical treatment is indicated, the simplest and most effective method should be chosen. In order to avoid problems in bone development in the subsequent years, it is necessary to cause minimal damage to the tissues, to perform minimal dissection, and to protect especially the locations of adhesion of the muscles and the periosteum as much as possible. In recent years, the use of bioabsorbable plates in the internal fixation of maxillofacial fractures has become widespread. However, these plates cannot be used in our clinic due to their high costs; titanium plates are preferred instead, and these plates are removed in a secondary surgery after 2-3 months.

ACKNOWLEDGMENTS: None

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Table 1: Distribution of gender and age

Gender	Number	%	Mean age (years)
Girls	22	25.3	9.09
Boys	65	74.7	11.35
Total	87	100	10.78

Table 2: Distribution of etiology by gender

			Boys	Girls	Total
Etiology	**Fall**	Number	30	12	42
		%	34.5	13.8	48.3
	In-vehicle traffic accidents	Number	5	2	7
		%	5.7	2,3	8
	Non-vehicletraffic accidents	Number	4	3	7
		%	4.6	3.4	8
	Pounding	Number	8	1	9
		%	9.2	1.1	10.3
	Motorcycle accident	Number	14	2	16
		%	16.1	2.3	18.4

		Boys	Girls	Total
Other	Number	4	2	6
	%	4.6	2.3	6.9
Total	Number	65	22	87
	%	74.7	25.3	100

Table 3: Distribution of facial bone fractures by localization

Location of fracture	**Number**	**%**
Isolated single condyle	7	8.04
Isolated bilateral condyle	2	2.29
Symphysis	4	4.59
Parasymphysis	7	8.04
Orbital floor	6	6.89
Condyle+symphysis/parasymphysis	10	11.49
Alveolus	1	1.14
Maxilla	3	3.44
Panfacial	24	27.58
Corpus+ ramus/angulus	10	11.49
Corpus+parasymphysis	6	6.89
Bilateral condyle+ mandibular	5	5.74
Parasymphysis+ orbita	2	2.29
Total	87	100

Table 4: Distribution of patients by the operation methods

Operation	**Number**	**%**
Arch bar	12	13.79
Open reduction-internal fixation	31	35.63
Closed reduction of zygoma + open reduction-internal fixation	2	2.29
Arch bar + open reduction internal fixation	22	25.28
Intermaxillary fixation screw + open reduction internal fixation	4	4.59
Condylectomy + open reduction internal fixation + arch bar	1	1.14
Open reduction internal fixation + arch bar / intermaxillary fixation with different operation	3	3.44
other	5	5.74
gap arthroplasty + open reduction-internal fixation + arch bar	1	1.14
Arch bar + intermaxillary fixation screw with different operations	2	2.29
Cartilage graft/Medpor	4	4.59
Total	87	100