Complications in Pediatric Facial Fractures

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ABSTRACT

Despite recent advances in the diagnosis, treatment, and prevention of pediatric facial fractures, little has been published on the complications of these fractures. The existing literature is highly variable regarding both the definition and the reporting of adverse events. Although the incidence of pediatric facial fractures is relative low, they are strongly associated with other serious injuries. Both the fractures and their treatment may have long-term consequence on growth and development of the immature face. This article is a selective review of the literature on facial fracture complications with special emphasis on the complications unique to pediatric patients. We also present our classification system to evaluate adverse outcomes associated with pediatric facial fractures. Prospective, long-term studies are needed to fully understand and appreciate the complexity of treating children with facial fractures and determining the true incidence, subsequent growth, and nature of their complications.

KEYWORDS: Pediatric facial fracture, complications

The treatment of pediatric facial fractures is constantly evolving, and recent advances in prevention, diagnosis, and management were reviewed by Zimmermann et al in 2006.¹ This article is a selective review of the literature, expanding upon the adverse outcomes or complications commonly seen during the management of pediatric facial trauma patients. Although pediatric facial fractures are not common, comprising only 3 to 6% of all facial fractures (4%,^{2,3} 6.5%,⁴ 5.9%,⁵ 5.7%,⁶ 3%⁷), their treatment requires expertise in the acute management of the fractures and their associated injuries, as well as an understanding of age-related facial anatomy and growth biology for long-term follow-up.

When discussing complications and adverse outcomes related to facial fractures, our group has defined three unique types of adverse outcomes that should be considered: type 1—those intrinsic to, or concomitant with the fracture itself (i.e., the loss of a permanent tooth with a mandible fracture); type 2—those secondary to intervention and surgical management (i.e., marginal

mandibular nerve palsy after open reduction and internal fixation of a mandible fracture); and type 3—those resulting from subsequent growth and development (i.e., asymmetric mandibular growth after condylar fracture). A patient may have any or all of these types of adverse outcome (i.e., malocclusion following mandibular fracture that may be a manifestation of the fracture, its treatment, or even the subsequent growth of the patient). The majority of the current literature focuses on the complications that are associated with the fractures, with few reporting on surgical complications and even fewer reporting on long-term growth and developmentally associated adverse outcomes in the pediatric population. It is difficult to compare the existing data in the literature regarding complications and adverse outcomes, as various centers have different treatment protocols and no agreed-upon definition of a “complication” or adverse outcome. When complication data are presented, it is generally in the general scheme of the report and seldom as the focus of the report. To our knowledge,

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there has not been a review article looking specifically at adverse outcomes in the presentation and the management of pediatric facial fractures. The overall complication rates reported in literature for both the adult and the pediatric patients range from 7.4 to 27.8% (27.8%,⁸ 7.4%,² 25%,⁴ 21.6%⁹); this wide range further underlines the variability in diagnosing and reporting these adverse outcomes.

ADVERSE OUTCOMES ASSOCIATED WITH FACIAL FRACTURES

Concomitant Injuries

Due to a large cranium-to-body ratio, pediatric facial fractures are highly associated with injury to the skull and the brain (47%).¹⁰ In the study by Eggenesperger Wymann et al, skull fractures occur in over 50% of craniofacial fractures in children.¹¹ In their study, the average patient age was 6 years old, younger than most other series. These data further emphasize that the young child is at an increased risk of skull and brain trauma when injured. Another study by Gassner et al reported 5% incidence of brain injury in children with craniomaxillofacial trauma.¹²

In the pediatric population, it is well documented that facial fractures are associated with an increased likelihood of ocular trauma, especially when the fractures involve the midface and the frontal region.¹³ Studies have reported a 20 to 24% incidence of blindness associated with orbital and midfacial fractures due to traumatic optic nerve injury and ruptured globe.^{14,15}

Aside from blindness, there are a myriad of other ocular injuries associated with facial trauma. Holt et al found an ocular injury incidence of 67% in adult maxillofacial trauma patients who had a full ophthalmologic

examination; 3% of these eye injuries were blinding.¹⁶ Hatton et al reported a 50% incidence of ocular injuries associated with orbital fractures in the pediatric population.¹⁷ Joseph et al devised a three-variable logistic regression equation to predict the probability of serious eye injury or blindness using Glasgow eye opening, pupillary reaction, and facial fractures as the variables. It is evident from their study that the identification of nonreactive pupils and afferent pupillary defect is of the utmost importance in predicting serious eye injury.¹⁸ A thorough ophthalmic examination in children can be difficult to perform due to the injured children's inability to cooperate and to effectively communicate symptoms. Based on this literature, we recommend a formal ophthalmic consultation for children suffering from facial fractures with the specific concern for both blunt and penetrating eye injuries.

Soft tissue injuries associated with other facial injuries have been reported in as many as 55.6% of patients in some studies of children with facial fractures (39%,¹⁰ 55.6%⁹). These wounds often lead to poor scarring as an adverse outcome (Fig. 1).¹⁰ In the retrospective study of pediatric maxillofacial fractures by Ferreira et al, 358 patients had associated facial lacerations, making it the most common concomitant injury in that series; 33 of these patients developed scarring ultimately requiring revision. One study found that unsightly scars comprised of 6.5% of patients' long-term morbidity following facial fractures.⁴

Dentoalveolar injuries, although often referred directly to pediatric dentistry, are also seen frequently in combination with other facial fractures. The incidence of associated dental injury has been reported as high as 48%, with preponderance toward children less than 10 years of age.¹⁹ The types of dental injuries typically seen include subluxation, crown fractures, avulsions, intrusions, concussions, and root fractures.¹²

Figure 1 Bad scarring following facial trauma and fracture.

Associated posttraumatic nerve injury seen in patients with facial fracture may be more prevalent than reported. Sensory nerve disturbances range from 3.8%⁴ to 23.9%.²⁰ Cope et al reported a 13% incidence of infraorbital dysesthesia after blowout orbital fracture in children that lasted longer than 1 month,²¹ and Zingg et al reported a 23.9% incidence of infraorbital nerve dysfunction after zygomaticomaxillary complex (ZMC) fractures.²⁰ These impairments are generally attributed to fracture displacement or surgical intervention. Taste and olfactory disturbances associated with upper and middle third facial fractures have also been reported.^{22,23} One case of facial nerve palsy of unknown etiology was reported in a Nigerian study of 37 pediatric patients who sustained facial fractures.⁹ Persistent cranial nerve III palsy following facial fracture has also been reported in the pediatric population.²⁴

ADVERSE OUTCOMES ASSOCIATED WITH THE SPECIFIC FRACTURE

Frontal/Basal Skull Fractures

Until the development of the frontal sinus, impact to the frontal skull often results in "craniofacial" fractures, extending obliquely to the facial bones or posteriorly along the cranial base/orbital roof. This pattern of injury largely depends upon the mechanism and force of injury, ranging from a simple fall from standing to a high-velocity motor vehicle collision or a fall from great heights. Operative management depends upon the presence of intracranial injuries, the degree of displacement, and the appearance-related deformity that may ensue. It is important to remember that in the pediatric population, the frontal bone, superior orbital roof, and anterior cranial base comprise the upper half of the orbit.

After the development of the frontal sinus, the treatment algorithm follows that of the adult patient, with obliteration of the sinus or cranialization of the sinus as indicated.²⁵ Although the fracture pattern is altered by the aeration of the frontal sinus, these fractures are nonetheless strongly associated with orbital fractures and ocular injury as often as 26% of the time.²⁵ Adverse effects include cerebrospinal fluid (CSF) leak, meningitis, sinusitis, and the delayed presentation of mucocoeles²⁶ or mucopyoceles.

Of all the craniofacial fractures, the basal skull fractures/cribriform plate fractures present the highest risk of CSF rhinorrhea or otorrhea.^{27,28} Seventy to 85% of CSF leaks following craniofacial fractures spontaneously resolve within 1 week of conservative treatment. Those CSF leaks refractory to conservative treatment and persisting beyond 7 days are typically treated with a lumbar drain for an additional 5 to 7 days prior to receiving formal surgical repair if needed.^{27,28}

There does not appear to be any correlation between the use of prophylactic antibiotics and the development of meningitis.

Orbital Roof Fractures

In the pediatric population, the incidence reported in literature of orbital roof fractures is as high as 13%.²⁹ Orbital roof fractures associated with skull fractures are common in young children due to their higher cranium-to-facial skeleton ratios, and most are also associated with additional facial fractures.³⁰ Aside from temporary periorbital edema and ecchymosis, they can also present with serious ocular injuries and underlying neurological injuries including pneumocephalus, dural tears, and cerebral hemorrhages and contusions. The acute management of orbital roof fractures is dictated by ocular and neurological signs and symptoms. Pulsatile proptosis, exophthalmos, compression of the globe or optic nerve, and traumatic encephalocele are indications for surgical intervention. Dural tears with or without CSF leak may also be indications for surgical repair. Although most CSF leaks spontaneously resolve within 14 days, there is a reported increased risk of meningitis. If surgical intervention is indicated, a combined procedure with neurosurgery using a transcranial approach is preferred. This allows for the examination and repair of any dural tears as well as bone grafting of the orbital roof defect.

Growing Skull Fractures

As orbital roof and anterior cranial base fractures can be associated with dural disruption, it is important to be aware of the phenomenon of growing skull fracture. The seemingly benign minimal bony fracture may be associated with a silent dural tear or a partial dural disruption that may evolve into a situation where constant cerebral pulsations drive the brain through an enlarging fracture well after the initial time of injury. Prior reports have described the incidence of growing skull fracture in all areas of the cranium to be 0.03 to 1% and occurring mainly in children younger than 3 years of age.^{31,32} There are only a handful of case reports of growing skull fractures involving the cranial base and orbital roof, mainly in the neurosurgery literature.³¹⁻³⁷ The typical clinical presentation of a growing skull fracture includes diplopia, proptosis, pulsatile exophthalmos, eyelid swelling, or orbital asymmetry. In a nine-patient series report by Amirjamshidi et al, the average age at presentation was 6.7 years, higher than expected when compared with all growing skull fractures.³¹ The patients presented anywhere from 2 months to 18 months after the initial injury. The very suspicion of this condition warrants prompt imaging and treatment. The surgical repair of a growing skull fracture includes a transcranial approach with the neurosurgeons for the isolation and reduction/

resection of neuroleptomeningeal "cyst," a water-tight dural repair, and a bone graft reconstruction of the anterior skull base/orbital roof.^{31,32,35} Postoperatively, these children should be monitored for persistent CSF leaks that may recur even after a successful initial repair. Despite surgical correction, some patients eventually require secondary intervention to restore the axis of the orbit³¹ or to correct orbital asymmetry.

Orbital Floor Fractures

In the pediatric population, the incidence of pure orbital fractures is higher than in the adult population. In a study by Losee et al,²⁹ 40% of children with the diagnosis of orbital fractures had pure orbital wall fractures not involving the orbital rims or the zygoma. In these 32 children with pure orbital fractures, 76% involved the orbital floor, consistent with the 71% observed by Bansagi and Meyer.³⁸ Despite large bony defects seen on computed tomography (CT), only 3 of the 32 children required surgery for acute, clinically significant enophthalmos or muscle entrapment. All patients in this series, both conservatively treated and surgically treated, were evaluated by ophthalmologists and none had lasting diplopia. This is in contrast to study by Cope et al, where 36% of their group of pediatric patients had diplopia lasting longer than 1 month after injury.²¹ One explanation may be patient selection bias. In their study, Cope et al reported that 39 of the 45 children presented with blurry vision or double vision, and 31 of these 45 children underwent orbital exploration and floor repair. Therefore, children presenting with diplopia may be more likely to have lasting diplopia despite surgical repair; it is unclear if surgical manipulation of the orbit could have induced postoperative scarring resulting in lasting diplopia.

Another adverse outcome of pure orbital floor fracture is inferior rectus muscle or orbital soft tissue entrapment in a "trapdoor"-type fracture. Orbital content entrapment has been described to present with the oculocardiac reflex and the triad of bradycardia, nausea, and syncope,³⁹ as well as the presence of extraocular muscle motility restriction and pain.^{38,40} In the pediatric population, symptomatic orbital tissue entrapment constitutes a surgical emergency and requires urgent surgical intervention unless otherwise contraindicated by overall condition or ocular injuries that may be exacerbated with orbital reconstruction.⁴¹ The timing of intervention for trapdoor fractures without systemic symptoms is less clear. Although there is no study dictating the timing of surgical intervention, there has been a report of ischemic necrosis of the entrapped tissue at 72 hours after the injury.³⁹ Several authors advocate surgical intervention within 2 days of injury.^{41,42} One study looked specifically at trapdoor fractures and found greater ocular motility recovery in the group of patients

who had surgical repair within 2 weeks.⁷ Egbert et al reviewed a series of pediatric pure orbital floor fractures with and without entrapment and demonstrated no difference in diplopia and duction deficits in patients receiving surgery within 1 month of injury.⁴⁰ The presence of ocular dysmotility with pain, nausea, vomiting, or cardiovascular symptoms should prompt surgical intervention even if no entrapment is demonstrated by CT scan; conversely, in the absence of clinical symptoms, a CT scan alone should not dictate surgical intervention in children with orbital floor fractures.²⁹

Zygomaticomaxillary Complex Fractures

It is known that pediatric bones have greater resiliency and elasticity than those in adults, with ligaments and periosteum that are more resistant to tearing and sutures that are more mobile.^{43,44} This can be seen in the frequency of greenstick fractures, minimally displaced fractures, and the rarity of comminuted fractures in the pediatric age group. It is also this elastic characteristic that can make adequate, precise reduction of impacted, greenstick facial fractures a difficult task. This is especially seen in pediatric zygoma and midfacial fractures where the fracture lines are often "impacted" instead of clean breaks with complete displacement. These fractures may be difficult to adequately mobilize and reduce without completion osteotomies.

Common complications and adverse outcomes in pediatric ZMC fractures are similar to that found in the adult population: persistent hypoesthesia in the infraorbital nerve (V2) distribution, enophthalmos, facial widening, and flattening of the malar region despite open treatment. The lower eyelid surgical approaches also carry the risk of poor scarring and ectropion. In a retrospective study by Gomes et al,⁴⁵ a complication rate of 6.2% was reported for the treatment of ZMC fractures, the most frequent complications being infection, hypertrophic scar, ectropion, and scleral show. Notably, less than 3% of the study group was under 10 years of age. In a series of 1025 cases of ZMC fractures by Zingg et al, 23.9% had infraorbital nerve dysfunction and 3.9% had enophthalmos with diplopia postreduction.²⁰ In pediatric patients suffering from ZMC fractures, greenstick fractures may present with atypical fracture patterns. Careful assessment of the occlusion is important as these fractures may include the maxillae and the palate (Fig. 2).

Nasal Fractures

The reporting of nasal fractures is variable in the literature and likely represents a selection and treatment bias. Some pediatric series report nasal fractures as the most commonly experienced pediatric facial fracture,^{24,46,47} although other pediatric series consider

Figure 2 (A) Adolescent with right zygomaticomaxillary complex (ZMC) fracture. (B) Bite demonstrating malocclusion associated with greenstick atypical ZMC fracture. (C) Malocclusion associated with greenstick atypical ZMC fracture. (D) Dental cast of malocclusion.

it an associated injury.¹⁰ Septal hematoma is infrequent, with only one case reported out of 55 nasal fractures in the Kaban et al series,²⁴ and 1% in the Dommerby and Tos series.⁴⁸ Significant pediatric nasal fractures, both untreated and appropriately treated, may potentially develop an exacerbation of external nasal deformity, progressive septal deviation with nasal airway obstruction, and even saddlenose deformity (Fig. 3). In the pediatric population, aggressive open septorhinoplasties are avoided until skeletal maturity, and early closed reductions are recommended. In long-term follow-up studies of pediatric nasal fractures treated with closed reduction, there was a minimal functional difference when compared with control patients without nasal fractures.⁴⁹ However, over 50% of these patients had some deformity of the external nose,⁴⁸ including bony and cartilage deviations, humps, and saddle deformations.⁴⁹ Therefore, although early closed reduction of pediatric nasal fractures may improve or minimize the initial deformity and decrease the vector of potential abnormal growth, secondary corrections may still be needed at skeletal maturity.

Le Fort/Maxillary/Midfacial Fractures

The most common midfacial fractures are isolated maxillary alveolar ridge fractures and, when included in the study,^{50,51} nasal fractures.^{24,47} In children less than 6 years of age, the incidence of an alveolar fracture is as high as 60% of all facial fractures.⁵² The maxillary incisor is the most commonly injured tooth associated with facial trauma¹⁹ and often requires dental splinting if significantly affected. Alveolar fractures are at a higher risk for long-term malocclusion if not adequately immobilized.⁵¹ With increasing age, the incidence of alveolar ridge fractures decreases as the incidence of typical maxillary fractures increases. This may be attributed to the changing characteristics of the maxilla with the enlargement of sinuses and the replacement of unerupted dentition with bone.

Le Fort pattern midfacial fractures are rarely seen in younger children prior to permanent dentition.⁵³ This is likely due to characteristics of the immature maxilla and its relative protected position by the large forehead. When present, Le Fort fractures are generally seen with high-energy injuries and often are multilevel and rarely

Figure 3 Preadolescent with follow-up saddlenose deformity following facial trauma and nasal fracture as infant.

isolated. They have been observed to be associated with nasoethmoidal, zygomatic, orbital, and mandibular fractures.⁵³ The association with neurosurgical, orthopedic, ophthalmologic, and multisystem injuries is also high.⁴⁷

Although the focus of concern with significant midfacial fractures is often the restoration of normal occlusion, in a prospective study by O'Sullivan et al of 100 patients with midfacial fractures (eight patients in the 10- to 19-year age group), the majority of complications were seen in the orbital region with 20% enophthalmos, orbital dystopia, or canthal deformities.⁵³ In primary or mixed dentition, the placement of internal fixation hardware is challenging due to the risk of injuring unerupted permanent tooth follicles. Dental splinting or drop pyriform wires may be needed in place of direct plating. Fortunately, mild malocclusion at this age has the potential to be improved through bony remodeling, the eruption of permanent dentition, compensation of the mastication mechanism, and posttraumatic orthodontia.

Mandibular Fractures

Some studies report the mandible as the most commonly fractured facial bone in children.^{1,9,50,54,55} Unlike the adult mandible, the condyle is the most common fracture site, especially in pediatric series with preadolescent children.^{1,46,54,56-58} The specific location of "condylar" fractures is age related, with children younger than 5 more likely to sustain intracapsular fractures and condylar neck fractures. With increasing age, there is a shift toward more inferior fracture sites, with adolescents older than 12 years of age sustaining largely subcondylar fractures.⁵⁹

Condylar fractures have been reported to carry the risk of growth disturbances and facial asymmetry,⁶⁰ with

the historical hypothesis that mandibular growth deficiencies would be greater the younger the age of the initial fracture. Although this makes intuitive sense, Demianczuk et al showed that the greatest risk for significant growth disturbances was in the 4- to 7-year-old and 7- to 11-year-old age groups,⁶¹ observing respectively that 24% and 16% of these children needed orthognathic surgery to correct their growth disturbances. Their hypothesis is that prior to the age of 4, the condylar region receives increased blood flow, promoting regeneration, an advantage that is lost with increasing age. After the age of 12 years, the majority of growth attributed to the condyles is complete, and less severe effects from injury to the condyles are seen. Although the incidence of undiagnosed condylar fracture in infants and toddlers is unknown, there have been case series of young children who present later in childhood or adolescence with facial asymmetry warranting orthognathic surgery.⁶¹ There has been a case report of injury to the internal maxillary artery associated with condylar fracture causing expanding hematoma 2 months after injury.⁶²

The current management for the majority of pediatric condylar fractures is conservative,⁶³⁻⁶⁵ and acceptable results have been reported in this group of patients with conservative functional therapy.⁶⁶ For the older patient near skeletal maturity with a complex fracture, open surgical treatment may be appropriate but carries the risk of injury to the facial nerve, external facial scarring, and condylar resorption.^{67,68} Regardless of management, condylar fractures with dislocation of the condylar head out of the glenoid fossa carry the potential of long-term mandibular midline deviation to the side of the dislocation both at rest and upon mouth opening, temporomandibular joint (TMJ) dysfunction, flattening of the glenoid fossa, decreased ramal height,

and retrognathia.^{65,67,69,70} Long-term incomplete condylar remodeling is frequent seen radiologically but does not seem to positively correlate with clinical TMJ dysfunction.^{65,71} The functional capacity of the pediatric mandible to compensate for condylar fractures has been observed to diminish with increasing age.⁷¹ After the eruption of permanent dentition, the adolescent mandible may benefit from a surgical treatment protocol closer to that of the adult mandible.

With forceful impact, the condylar head may dislocate into the middle cranial fossa instead of fracturing at the condylar neck and displacing out of the glenoid fossa. In separate case reports and literature reviews by Harstall et al and Barron et al,^{72,73} 16 of the 32 cases of condylar head dislocation into the middle cranial fossa described in literature were in pediatric patients ages 18 and under. Six of the 16 patients had intracranial injuries in the form of intracranial bleeds,

dural tears, or contusions. Four had injuries to the external auditory canal and the middle ear, with hearing loss and facial paralysis in one patient. Two patient had long-term mandibular problems; one had fibroanklyosis treated by gap arthroplasty and a silicone interposition device, and the other had micrognathia treated by advancement genioplasty. Ten of the 16 patients were treated successfully with closed reduction and maxillo-mandibular fixation (MMF), three required open reduction by condylectomy, and three required craniotomy for reduction.

TMJ ankylosis is reported infrequently as an adverse outcome of pediatric mandibular fractures.^{5,24,54-56,74} Delayed diagnosis and treatment, prolonged MMF, and crush-type injury to the condylar head are thought to contribute to this phenomenon.

The incidence of adverse outcomes related to the surgical repair of the pediatric mandible is uncommon.

Figure 4 (A) Older child with developmental malocclusion following open reduction, internal fixation (ORIF) of mandibular fracture with titanium plate and screws. (B) Panorex X-ray of pediatric mandibular fracture treated with metallic ORIF.

Figure 5 Open reduction, internal fixation (ORIF) of infant mandibular fracture with resorbable plate on inferior border of mandible, access through facial laceration.

Improved vascularity and the lack of alcohol and tobacco abuse likely contribute to this phenomenon. Some authors described postsurgical complications to include malocclusion and trismus, but the most common postsurgical consequence is reoperation to remove either fixation hardware (Fig. 4) or intermaxillary fixation hardware.⁷⁵ Both surgically and nonsurgically treated patients must be monitored longitudinally for the development of late complications such as growth asymmetry, TMJ ankylosis or dysfunction, and injury or loss of permanent dentition.

ADVERSE OUTCOMES ASSOCIATED WITH SURGICAL REPAIR OF THE FRACTURE

Controversy exists regarding the method of fracture fixation in the pediatric patient, especially in the younger child with primary or mixed dentition. Although the standard titanium fixation systems carry the risk of translocation, growth restriction, and dental injury, their use may often be necessary in the load-bearing buttresses of the facial bones. Recent reports on the use of resorbable plates and screws offer a potential solution to the growing pediatric facial bone⁷⁶; however, some recommend limiting their use to passive fixation in low load-bearing areas and not relying upon them to “hold” reductions. However, with time and experience, their use has significantly increased (Fig. 5). The reported incidence of surgical complications associated with the reduction and fixation of facial fractures is generally less than 5%.^{55,77,78} These complications include infection, hardware malfunction, asymmetry, poor scarring, and malocclusion. Postoperative infection has been reported to range from 1.1 to 3.7% (3.7%,² 1.7%,⁴ 1.1%,⁷⁷ 1.2%⁵⁵).

CONCLUSION

Overall complication rates reported in facial fractures range from 7.4 to 27.8% depending on both the pattern

of management and reporting (27.8%,⁸ 7.4%,² 25%⁴). In the pediatric population, these rates have been reported to be similar (2.6%,⁴⁶ 5.7%,¹⁰ 21.6%⁹). However, given the complex situation in the growing child, these reported rates of postinjury adverse outcomes are likely biased and incorrect. To date, no appropriate classification systems have been applied to a large group of pediatric facial fracture patients followed adequately over a long period of time. With the low incidence of pediatric facial fractures, it is not unexpected that there is a paucity of literature regarding the true data of postinjury adverse outcomes. In this article, we presented our classification system: type 1—those intrinsic to or concomitant with the fracture itself; type 2—those secondary to intervention and surgical management; and type 3—those resulting from the fracture, its treatment, or subsequent normal or abnormal growth and development. To identify true rates of postinjury adverse outcomes, a classification system such as ours should be employed for consistency.

Although most agree that “a child is not just a small adult,” the reality is that a 2-year-old toddler is different from a 10-year-old child, and both are different from a 15-year-old adolescent. The surgeon choosing to care for pediatric patients with facial fractures must understand the treatment needs of each age group and be committed to follow these patients longitudinally for the potential deviations from normal growth and development. Large-scale, prospective, longitudinal studies, mindful of all types of postinjury adverse outcomes in the growing child, are needed to provide a better understanding of appropriate management to assure good outcomes.

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