



Pediatric Facial Fractures: Diagnostic Imaging, Dental Treatment, and Perioperative Nursing

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Abstract

Background: Pediatric facial fractures, though less common than in adults, pose significant diagnostic and therapeutic challenges due to the unique anatomical and developmental characteristics of the growing facial skeleton. These injuries often result from age-specific trauma mechanisms and carry risks of long-term functional and aesthetic consequences.

Aim: This study aims to provide a comprehensive overview of the etiology, diagnosis, management, and prognosis of pediatric facial fractures, emphasizing multidisciplinary care and age-appropriate strategies.

Methods: A detailed literature-based review was conducted, integrating current clinical practices in pediatric trauma, radiology, dentistry, and nursing. The article synthesizes anatomical, epidemiological, and procedural data to guide evaluation and treatment.

Results: Facial fractures in children vary by age and mechanism, with nasal and mandibular fractures being most prevalent. Imaging, particularly low-dose CT with 3D reconstruction, is essential for accurate diagnosis. Conservative management is often preferred due to high remodeling potential, while surgical intervention is reserved for displaced, function-threatening, or cosmetically significant fractures. Multidisciplinary coordination—including dental, surgical, ophthalmologic, and nursing teams—is critical for optimal outcomes. Long-term follow-up is necessary to monitor growth disturbances, malocclusion, and psychosocial effects.

Conclusion: Pediatric facial fractures require age-specific assessment and collaborative care. Early diagnosis, appropriate imaging, and tailored treatment strategies improve functional recovery and minimize long-term complications.

Keywords: Pediatric facial trauma, facial fractures, diagnostic imaging, dental management, perioperative nursing, multidisciplinary care, craniofacial growth, orbital injuries, mandibular fractures, child safety.

1. Introduction

Trauma is a leading cause of morbidity and mortality in children, with the head representing the most frequently injured region in pediatric patients [1]. Facial fractures are uncommon in very young children because of anatomical and developmental factors that confer relative resistance to bony injury. The pediatric face contains a greater proportion of elastic cartilage, and the cranial vault is relatively large compared with the facial skeleton, which distributes and attenuates

impact forces that would more readily fracture adult facial bones [2]. Nevertheless, when facial fractures occur in children, the injuries can be severe and carry potential for lifelong functional and aesthetic consequences. Fracture patterns in children differ from those seen in adults because of ongoing facial growth, the changing relationship of cranial and facial volumes, the timing of secondary dentition eruption, and progressive pneumatization of the paranasal sinuses. These developmental variables influence both

the location and the biomechanical response of facial bones to trauma and establish age-specific epidemiologic and management considerations [1]. The etiology of pediatric facial fractures varies with age, mechanism of injury, and local environment. In infants and toddlers, low-energy falls and nonaccidental trauma account for a greater proportion of facial injuries. In school-age children and adolescents, high-energy mechanisms, including motor vehicle collisions, sports injuries, and interpersonal violence, become more prominent. The pattern of forces involved, and the biomechanical properties of immature bone determine whether an impact produces greenstick fractures, nondisplaced linear fractures, or more complex comminuted injuries. Greenstick or incomplete fractures may be more common in younger children because the pediatric cortex bends before it breaks, whereas older children may display fracture patterns that resemble those of adults as the facial skeleton matures, and the sinuses enlarge. The timing of tooth eruption alters the load distribution through the maxilla and mandible and affects the stability of alveolar segments at the time of injury. Clinicians must therefore integrate age, dentition, and mechanism when interpreting imaging and planning treatment [1].

Facial fractures in children rarely occur in isolation. The proximity of facial bones to the brain, orbit, skull base, and airway elevates the risk of associated injuries that can determine initial priorities of care. Concomitant traumatic brain injury, orbital trauma with vision threat, cervical spine injury, and airway compromise must be identified and addressed promptly. The presence of multisystem trauma often dictates a staged approach in which life- and limb-saving interventions precede definitive management of facial skeletal injuries. In polytrauma cases, temporizing measures such as closed reduction or external stabilization may be necessary to protect airway patency and to control hemorrhage before definitive reconstruction. The pediatric airway demands specific attention because anatomical differences and smaller margins for error render children more vulnerable to rapid deterioration from edema, bleeding, or obstruction after facial trauma. Early involvement of anesthesiology and otolaryngology or trauma surgery may be required to secure the airway safely [1]. Imaging strategies for pediatric facial fractures must balance diagnostic yield with minimization of radiation exposure. Plain radiography retains a role for specific indications, but computed tomography provides superior sensitivity and anatomic detail for complex injuries, including orbital floor disruption, comminuted zygomaticomaxillary fractures, and skull base extension. Advances in imaging, including low-dose CT protocols and three-dimensional reconstruction, improve fracture characterization and operative planning while reducing radiation burden. Magnetic resonance imaging may be indicated when soft tissue,

vascular, or intracranial injury is suspected. Radiologic interpretation in pediatric patients requires knowledge of developmental anatomy; normal growth-related variants and unerupted teeth can mimic pathology, and false positive diagnoses may lead to unnecessary interventions. Multidisciplinary review of imaging with pediatric radiology, surgery, and dental specialists enhances diagnostic accuracy and informs appropriate timing of repair [1][2].



Figure-1: Pediatric Facial Fractures.

Management philosophy emphasizes restoration of function, preservation of facial growth potential, and minimization of long-term deformity. Conservative management, including observation and closed reduction, is often appropriate for nondisplaced or minimally displaced fractures in younger children because remodeling potential is high. Indications for open reduction and internal fixation expand with age, severity of displacement, involvement of occlusion, or risk to vision. When internal fixation is required, implant selection and surgical technique must account for future growth; resorbable fixation materials and minimally invasive approaches are favored when it is feasible to reduce interference with skeletal maturation. Dental involvement is integral when fractures involve alveolar processes or tooth-bearing segments, timely management of tooth injuries and stabilization of occlusion influences both functional and developmental outcomes. Outcome assessment extends beyond immediate fracture healing to encompass long-term facial growth, dental development, psychosocial adaptation, and quality of life. Children who sustain facial fractures require longitudinal follow-up to identify growth disturbances, malocclusion, or asymmetry that may emerge gradually. Early referral pathways that integrate dental, surgical, radiologic, and nursing care optimize both acute management and long-term surveillance. Preventive strategies, including education on child safety, use of appropriate protective equipment in sports, and adherence to vehicle restraint guidelines, are essential to reduce the incidence and

severity of pediatric facial trauma. In sum, pediatric facial fractures present a distinct clinical spectrum shaped by growth and development. Optimal care depends on age-specific assessment, multidisciplinary collaboration, and a long-term view that prioritizes functional restoration and preservation of normal facial growth [3][4][5][6][7][8].

Anatomy, Development, and Vulnerabilities of the Pediatric Facial Skeleton

The pediatric facial skeleton comprises a series of paired and unpaired bones that form the structural framework of the midface, upper face, and mandible. Principal elements include the paired maxillae, which house the alveolar processes and support the upper dentition; the mandible, the only mobile component of the craniofacial skeleton that bears the lower dentition; the paired zygomatic bones that form the cheek prominence and contribute to the lateral orbital rim; the paired nasal bones that form the osseous nasal bridge; and the frontal bone that forms the forehead and superior orbital rim. The cranial vault and base, formed by the parietal, temporal, occipital, sphenoid, and ethmoid bones, provide protection to the brain and create the structural relationships that influence facial biomechanics. These anatomic relationships are dynamic in childhood because growth and developmental processes continually alter bone shape, thickness, and relative position, and those changes determine both fracture patterns and clinical consequences. Neonatal and early infant craniofacial proportions differ markedly from those of adults. The neonatal skull volume substantially exceeds facial volume, producing an approximately 8:1 cranial-to-facial ratio at birth compared with an adult ratio near 2:1. The frontal convexity and prominent cranial vault in infants redirect external forces away from the nascent facial skeleton, so impact that would fracture an adult midface more often injures the skull in young children [9][10]. As the face grows and the maxilla and mandible expand with dental eruption and sinus pneumatization, the relative vulnerability of various facial subunits shifts. By adolescence the craniofacial proportions more closely approximate adult geometry, and fracture patterns converge toward those seen in mature skeletons.

Bone composition and material properties further protect the pediatric face from fracture but also produce distinct injury morphologies. Pediatric facial bone contains a higher proportion of elastic cartilage and a thicker periosteum than adult bone. Under load, immature cortical bone tends to deform and partially fracture rather than produce complete, comminuted breaks. As a result, incomplete or greenstick fractures, minimal displacement, and bending deformities are more common in young children than adult-type transverse or comminuted fractures [11]. The thick periosteum frequently maintains alignment and facilitates remodeling, which informs conservative management decisions and the expectation of

substantial spontaneous correction in younger patients. Age-dependent sinus development and dental eruption substantially influence midfacial strength and the transmission of impact forces. Maxillary sinuses are present at birth but are small; progressive pneumatization occurs through early childhood and into the school years. During the period of active pneumatization, the midface retains relative thickness and resistance to fracture. As pneumatization progresses and sinus volume increases, thin cortical walls replace thicker bone, altering force transmission and raising susceptibility to certain fracture types. For example, orbital roof fractures are more likely in very young children because midfacial thickness transmits force superiorly to the thinner frontal bone, whereas orbital floor and floor wall injuries, including blowout fractures, increase in frequency as the orbital floor thins during later childhood and adolescence [12][13].

Dentition exerts a comparable influence. Eruption of deciduous and mixed dentition modifies load distribution across the maxilla and mandible. The presence of developing tooth germs and unerupted permanent teeth changes the structural continuity of alveolar bone and confers both strength in some vectors and fragility in others. Mandibular fractures remain the second most common facial fracture in children and often involve the condylar head or subcondylar region. Condylar injuries are common because the condyle functions as a growth center and assumes significant mechanical load during impact. In children, condylar fractures may be minimally displaced yet carry disproportionate long-term risk because disruption of the condylar growth cartilage can lead to mandibular asymmetry, malocclusion, restricted jaw opening, or temporomandibular joint dysfunction over time. Nasal bone fractures predominate overall in the pediatric population because the nasal bridge projects anteriorly and lacks robust lateral support. The thin nasal bones and minimal soft tissue barrier render the nose vulnerable to direct impact, with attendant risks to the growing nasal septum. Septal injuries in childhood may have significant implications for midfacial growth and future nasal form. Alveolar and dentoalveolar injuries are also frequent in young children and may involve tooth intrusion, displacement, or avulsion. These injuries carry implications for dental development and occlusion that demand early dental or oral and maxillofacial specialist input [12][13].

Certain anatomic zones bear heightened vulnerability because they concentrate stress or contain growth centers. The naso-orbitoethmoid complex, the zygomaticomaxillary buttress, and the mandibular condyle represent key load-bearing structures and growth centers whose injury can disrupt facial harmony. Similarly, the thin orbital walls and the inferomedial orbital rim are at risk for trapdoor or entrapment-type fractures in children, where flexible bone snaps and then recoils, entrapping soft tissues or

extraocular muscles and creating an urgent indication for reduction to prevent ischemic muscle injury and persistent diplopia. The implications of these developmental and anatomic features extend beyond immediate fracture management. Pediatric fractures require assessment for associated injuries that may be occult, including traumatic brain injury, skull base fractures, ocular trauma, and cervical spine injury. Imaging strategy must balance diagnostic accuracy with radiation stewardship; low-dose computed tomography with three-dimensional reconstruction is often preferred for detailed bony assessment, whereas magnetic resonance imaging is reserved for soft tissue, vascular, or intracranial concerns. Interpretation requires awareness of normal developmental variants, including suture patency, accessory ossification centers, and unerupted teeth, to avoid misdiagnosis. Long-term surveillance is a core component of care because growth disturbance, facial asymmetry, dental malocclusion, and temporomandibular dysfunction may appear months to years after the initial event. Early involvement of a multidisciplinary team that includes pediatric surgery, oral and maxillofacial surgery, pediatric dentistry, otolaryngology, radiology, and rehabilitation services supports both acute stabilization and longitudinal monitoring. Treatment decisions must weigh the immediate need for anatomic restoration against the potential for growth-mediated remodeling, favoring conservative approaches where appropriate and reserving open reduction and fixation for fractures that threaten function or appearance or that will not remodel adequately with growth [14].

Etiology

Facial fractures in the pediatric population result from a diverse range of traumatic events, with blunt trauma constituting the predominant mechanism. Falls represent the most frequent cause, especially in toddlers and younger children, due to their underdeveloped coordination, relatively large head-to-body ratio, and natural proclivity for exploration without awareness of environmental hazards. Sports-related injuries constitute another important source of facial trauma in school-aged children and adolescents. Contact sports such as football, basketball, and hockey, as well as recreational activities like bicycling, skateboarding, or horseback riding, increase the likelihood of direct blows to the face and contribute substantially to fracture incidence. In adolescents, failure to use protective gear, such as helmets or face guards, further exacerbates these risks [15]. Motor vehicle crashes (MVCs) remain one of the most severe causes of pediatric facial fractures. Unrestrained or improperly restrained children, including those not secured in age-appropriate car seats or booster seats, face heightened vulnerability. The high-energy transfer in MVCs can cause complex midfacial or mandibular fractures and is often associated with concomitant intracranial or cervical spine injuries. Assault also contributes, particularly in

adolescents, and ranges from interpersonal violence to non-accidental trauma. In younger children, suspected cases of child abuse warrant special attention, as facial injuries, including fractures, may serve as sentinel events. Recognition of such patterns is crucial because timely identification can prevent recurrent harm and ensure child safety [15]. Although less frequent, penetrating trauma represents another etiology. Gunshot wounds, though declining in prevalence in the United States, are associated with severe morbidity and complex reconstruction requirements when they occur [16]. These injuries often extend beyond the facial skeleton to involve the airway, vasculature, and intracranial contents, necessitating urgent multidisciplinary management. The variability of etiology underscores the importance of age-specific preventive strategies, including fall precautions for toddlers, sports safety equipment for adolescents, vehicular safety enforcement across all ages, and vigilance for non-accidental trauma in vulnerable children [15][16].

Epidemiology

Pediatric trauma accounts for substantial morbidity and mortality in the United States, producing roughly 12,000 deaths and more than 8 million emergency department visits annually. Facial fractures comprise a small fraction of overall facial trauma presentations; children represent under 15 percent of patients with facial fractures, and only 10 to 15 percent of pediatric facial injuries progress to craniomaxillofacial fractures. Most facial injuries in children are limited to soft tissues and are managed outside of hospital settings, which contributes to underreporting and complicates efforts to quantify true incidence. By contrast, fractures produce pain, swelling, and functional disturbance that more often prompt emergency evaluation, so fracture data drawn from trauma centers likely overrepresent severe patterns while underrepresenting minor injuries treated in outpatient or home settings [17][18][19]. Age stratification drives the distribution of pediatric facial fractures. Fractures are uncommon in children younger than six years; in that age group skull fractures exceed facial fractures because cranial anatomy and head-to-face proportions attenuate impact forces. Incidence rises through school age and peaks in adolescence, with roughly half of pediatric facial fracture presentations occurring in patients aged ten to eighteen. Adolescent boys sustain fractures at approximately twice the rate of adolescent girls, a disparity linked to activity patterns, exposure to high-energy mechanisms, and behavioral risk factors. Mechanism varies by age: infants and toddlers sustain most injuries from falls, school-age children from bicycle and sports accidents, and adolescents from motor vehicle crashes and interpersonal violence. Overall, motor vehicle collisions account for about half of pediatric facial fractures, with bicycle accidents and sports injuries comprising most of the remaining etiologies among school-age children [17][18][19].

Fracture site distribution reflects both mechanism and developmental anatomy. Nasal fractures are commonly perceived as the most frequent but are likely underreported because many are evaluated outside trauma centers. Reported data identify the mandible as the most commonly injured facial bone across pediatric age groups, involved in 40 to 60 percent of fracture cases and increasing in frequency with age. The pattern of mandibular injury often involves the condyle in younger patients, which has implications for growth and function. Alveolar ridge fractures predominate in the very young; they affect roughly 60 percent of fractured children under six years and decline in relative frequency with age as dentition and alveolar support mature. Orbital and midface fractures follow in frequency across age groups and reflect the changing pneumatization of the sinuses and progressive thinning of midfacial cortices during development [20]. Specific high-risk patterns merit emphasis because of their associated morbidity. Frontal bone fractures carry considerable intracranial risk; reported associations show intracranial injury in 35 to 64 percent of frontal fractures and cerebrospinal fluid leak in 18 to 36 percent. The frontal bone often functions as a crumple zone in young children, absorbing impact prior to full sinus development; that role can both protect the face and transmit force to the cranial vault, producing skull base injury. Nasoorbitoethmoid complex fractures are relatively uncommon in children, representing only 1 to 8 percent of pediatric facial fractures, but when present they pose a high risk for telecanthus, lacrimal injury, and long-term growth disturbance. Classic adult midfacial patterns such as Le Fort fractures are rare in children, accounting for less than 2 percent of pediatric facial fractures and occurring mainly in older adolescents whose facial anatomy approaches adult proportions [20].

Associated injuries define clinical priorities and resource needs. Facial fractures in children frequently coexist with injuries outside the face. Traumatic brain injury, cervical spine injury, ocular damage, and airway compromise appear with higher frequency in polytrauma presentations and dictate initial management priorities. The frequent concurrence of severe nonfacial injuries underscores the need for multidisciplinary trauma evaluation and the utility of trauma registries that capture associated injury patterns to inform prevention and care pathways. Underreporting of minor facial trauma and variability in coding practices further constrain epidemiologic interpretation. Many community-treated nasal fractures and soft tissue injuries do not enter centralized databases, producing a selection bias toward more severe, hospital-treated fractures in published series. Temporal trends and prevention signals are relevant to epidemiology. Declines in certain penetrating injuries, including some categories of gunshot wounds, have been reported in the United

States, though trends vary by region and demographic group. The distribution of mechanisms also changes with public health interventions; improvements in vehicle restraint use and helmet uptake reduce the incidence and severity of crash- and bicycle-related facial fractures. Surveillance that couples injury mechanism with demographic data allows targeted prevention strategies, such as mandated protective equipment in youth sports, booster seat legislation, and community interventions to reduce interpersonal violence [20].

Epidemiologic data have direct clinical and system implications. The concentration of fractures in older children and adolescents informs training priorities for emergency, surgical, dental, and radiologic teams. The high proportion of mandibular and orbital injuries guides imaging protocols and the selection of low-dose computed tomography with three-dimensional reconstruction when detailed bony assessment is required. The frequency of associated intracranial injury with frontal fractures stresses the need for early neurosurgical involvement and protocols for cerebrospinal fluid leak management. Public health planning must acknowledge the underreporting of minor injuries and incorporate outreach to primary care, dental, and school-based settings to improve data capture and preventive education. Finally, epidemiologic evidence supports structured follow-up and long-term surveillance. Because growth disturbance, malocclusion, and facial asymmetry may appear months to years after the initial injury, registries and care pathways that ensure longitudinal assessment are essential. Coordinated systems that link acute trauma care with dental, maxillofacial, and pediatric services improve detection of delayed sequelae and allow timely intervention to restore function and cosmesis. In sum, pediatric facial fracture epidemiology reflects an interplay of age, mechanism, anatomic development, and healthcare-seeking behavior; understanding that interplay is fundamental to clinical decision making, preventive policy, and resource allocation [17][18][19][20].

History and Physical

Significant force is required to fracture the pediatric facial skeleton, and the identification of a facial fracture should immediately prompt a systematic search for associated injuries. Evaluation must prioritize airway, breathing, and circulation according to Advanced Trauma Life Support principles because midfacial bleeding, tongue retrodisplacement from bilateral mandibular fractures, and expanding hematoma can produce rapid airway compromise. Similarly, cervical spine injury and traumatic brain injury are common coexisting conditions in high-energy mechanisms and should be excluded or stabilized before detailed facial assessment. The initial examination therefore focuses on life-threatening problems, hemodynamic status,

level of consciousness, and gross neurologic function, with definitive facial assessment deferred until the patient is physiologically secure [21][22]. Obtaining an accurate history is fundamental to risk stratification and planning, yet it is often challenging in children. A careful reconstruction of the mechanism of injury provides the best predictor of associated injuries and of fracture pattern; high-velocity mechanisms such as motor vehicle collisions and falls from height raise the index of suspicion for complex midface or cranial base injuries, whereas low-energy falls more commonly produce isolated soft-tissue trauma or nondisplaced fractures. Because young children may not be reliable historians, collateral information from parents, caregivers, teachers, or first responders is essential. Documentation should capture the sequence of events, the presence and evolution of neurologic symptoms, any loss of consciousness, emesis, seizures, visual disturbance, or new focal deficits, and the timing and content of the last oral intake if anesthesia or urgent operative intervention is being considered. Routine but critical medical history elements include preexisting medical conditions, use of anticoagulants or antiplatelet agents, allergy history, tetanus immunization status, and baseline developmental or behavioral issues that may affect cooperation with examination and imaging [21][22].

Symptom enquiry should target indicators of facial skeletal disruption. Patients or caregivers may report facial swelling, persistent or progressive pain, a sense of malocclusion, loose or avulsed teeth, visual changes, nasal obstruction, epistaxis, numbness in trigeminal nerve distributions, or a foreign body sensation in the orbit or oral cavity. The presence of persistent diplopia, new diplopia elicited by upward or downward gaze, enophthalmos, or an inability to close the eyelids should raise concern for orbital wall involvement or muscle entrapment. Clinicians should note any complaints of airway difficulty, voice change, or dysphagia, which may reflect soft tissue hematoma, laryngeal injury, or posterior displacement of mandibular segments [21][22]. The physical examination must be systematic and child-centered to maximize cooperation and diagnostic yield. A calm environment and parental presence often facilitate more complete assessment. Inspection begins with general appearance and respiratory effort and proceeds to a focused head and neck evaluation. External signs of injury include ecchymosis, abrasion, laceration, edema, facial asymmetry, and deformity. Palpation assesses bony continuity, step-offs, crepitus, and point tenderness while appreciating that periosteal elasticity and thick, soft tissues in children may mask displacement. Intraoral inspection examines occlusion, dental stability, mucosal lacerations, and palatal or alveolar defects. Sensory testing of the infraorbital, mental, and inferior alveolar distributions evaluates trigeminal nerve function and helps localize fractures of the maxilla, zygoma, and mandible. Mandibular range of motion should be documented;

limitation may indicate condylar injury or pain limiting function. Ocular examination includes visual acuity, when possible, pupillary responses, extraocular movements, assessment for globe rupture, and inspection for chemosis or subconjunctival hemorrhage. Any sign of entrapment, diplopia on gaze, or gross visual deficit necessitates urgent ophthalmologic consultation [21][22].

A focused airway examination is indispensable. External airway patency, stridor, muffled voice, expanding neck hematoma, subcutaneous emphysema, and drooling are red flags that mandate early involvement of anesthesiology and otolaryngology or trauma surgery for airway planning. Cervical spine precautions remain mandatory until cleared by clinical criteria or imaging. Bleeding control and temporary stabilization of grossly mobile fragments should be performed as needed to protect the airway and limit further soft-tissue injury [21][22]. Neurologic screening and cervical spine assessment form integral components of the secondary survey. Baseline Glasgow Coma Scale, cranial nerve screening, limb motor and sensory function, and coordination tests appropriate to the child's age should be recorded. Given the proximity of the frontal bone and orbit to intracranial structures, clinicians must remain vigilant for subtle neurologic changes that evolve over time. Headache, vomiting, and alteration in behavior may indicate escalating intracranial pathology. Examination techniques must be adapted to developmental level. Younger children benefit from distraction, play-based approaches, or gentle restraint by caregivers to permit inspection and palpation. The examiner should be mindful that crying and squirming can obscure tenderness and deformity and that a staged approach, with repeated assessments as distress subsides, often yields clearer findings. Documentation should include a diagram or photographs when permissible, as visual records assist surgical planning and medicolegal considerations. Finally, a comprehensive facial evaluation integrates history and examination findings with a low threshold for adjunctive imaging when clinical suspicion exists. Plain radiographs may have limited sensitivity in children; computed tomography with low-dose pediatric protocols remains the gold standard for characterizing complex fractures, evaluating orbital involvement, and identifying skull base or intracranial extension. Magnetic resonance imaging is reserved for soft tissue, vascular, or neurologic concerns. Whenever facial fractures are identified or strongly suspected, multidisciplinary consultation with pediatric trauma surgery, oral and maxillofacial surgery, otolaryngology, ophthalmology, and anesthesiology should be mobilized early to coordinate airway management, operative timing, and definitive care. A cranial nerve evaluation should complete every thorough head and neck physical examination [21][22].

Musculoskeletal and skin examination

Wound assessment in pediatric facial trauma must determine the extent of damage to soft tissues and underlying musculoskeletal structures, with particular attention to muscles, tendons, vessels, nerves, and salivary ducts. Penetrating wounds and complex lacerations require careful appraisal for involvement of the facial nerve branches and the parotid duct; failure to recognize ductal transection can lead to sialocele formation and chronic fistulae, while unrecognized injury to motor branches of the facial nerve produces functional deficits that have both immediate and long-term consequences. Facial nerve palsy following blunt trauma is highly suggestive of temporal bone involvement or direct neural disruption and should prompt expedited otologic and neuroimaging evaluation. Early documentation of facial movement across the distribution of the temporal, zygomatic, buccal, marginal mandibular, and cervical branches is essential for baseline comparison and for guiding timing of repair or decompression when indicated [23][24]. Palpation of the facial skeleton must be systematic and gentle, recognizing that pediatric periosteum and soft tissue elasticity may mask displacement. Bony tenderness and localized soft tissue swelling are common but nonspecific findings; crepitus contiguous with sinus regions or palpable step-offs along the zygomaticomaxillary buttress, infraorbital rim, orbital floor, or mandibular body correlate more strongly with underlying fracture. Mobility of bone segments on palpation, instability of alveolar segments, and discontinuity of occlusal relationships provide higher diagnostic specificity and should lower the threshold for advanced imaging. Range of motion of the mandible should be measured and documented; trismus or reduced interincisal opening may reflect pain, muscular spasm, or intra-articular pathology such as condylar fracture and must be discriminated from neuropathic or soft tissue causes [23][24].

Assessment of soft tissue injury includes evaluation of muscle function and tendon continuity where relevant. The masseter and temporalis muscles warrant inspection for hematoma or functional impairment when mandibular injury is suspected. Tendinous injury in periocular or perioral lacerations can compromise expressive and protective functions and should be explored under appropriate anesthesia to permit precise repair. Vascular integrity is determined by inspection of expanding hematoma, ongoing hemorrhage, and perfusion of distal tissues; compromised perfusion or pulsatile bleeding mandates urgent surgical control. Sensory testing of trigeminal nerve divisions supplies additional localization information; numbness in the infraorbital or mental distributions frequently accompanies maxillary or mandibular fractures and predicts neural compromise that may require longitudinal follow-up [23][24][25]. The ocular examination should be undertaken early

when direct periocular trauma is suspected because periorbital edema can rapidly obscure signs of globe or orbital injury. Extraocular motility must be assessed to detect entrapment syndromes, particularly in the pediatric population where “white-eyed” blowout fractures may present with minimal external soft tissue signs despite muscle incarceration. Restricted upward or downward gaze accompanied by nausea, bradycardia, or syncope signals a pronounced oculocardiac reflex and represents a surgical emergency to release entrapped tissue and avert ischemic muscle injury and persistent diplopia [25]. Examination must also document visual acuity, afferent pupillary defect, globe integrity, anterior chamber depth, and the presence of proptosis, enophthalmos, chemosis, or subconjunctival hemorrhage. Any suggestion of optic nerve compromise or globe rupture necessitates immediate ophthalmologic consultation and influences surgical sequencing [25].

Intraoral inspection is integral to the musculoskeletal evaluation. The oral cavity should be examined for mucosal lacerations, palatal disruptions, alveolar fracture lines, tooth mobility, and occlusal derangement. Dental status and the presence of mixed or unerupted dentition affect both fracture pattern and treatment strategy. Tooth mobility may reflect isolated dental trauma, alveolar process fractures, or more extensive maxillary or mandibular instability. Examination for malocclusion at rest and during attempted closure clarifies functional impairment; a maloccluded bite or crossbite after trauma strongly indicates mandibular or maxillary displacement. Palpation of the alveolar ridge and visualization of gingival ecchymosis aid in diagnosing occult alveolar fractures, which are especially prevalent in very young children and carry implications for dental development [23][24][25]. Because the mandible commonly fractures in two locations, detection of one mandibular fracture should prompt targeted assessment for a second occult site. Tongue position must be noted; posterior displacement associated with bilaterally unstable mandibular segments can compromise the airway and requires prompt stabilization. When lacerations expose bone or when tooth fragments are avulsed, prompt irrigation, debridement, and staged reconstruction should be planned with dental and maxillofacial colleagues to preserve occlusion and tooth vitality. Documentation of neurovascular status, dental findings, and musculoskeletal deficits at presentation is essential for operative planning and medicolegal records. Overall, the musculoskeletal and skin examination in pediatric facial trauma demands a methodical, developmentally appropriate approach that integrates palpation, functional testing, sensory evaluation, and early ocular assessment. Findings that suggest instability, entrapment, neural injury, or vascular compromise should trigger rapid imaging, specialist consultation,

and timely operative intervention to prevent permanent functional loss and to optimize long-term craniofacial growth and development. [23][24][25]

Evaluation

The evaluation of pediatric patients with suspected facial fractures requires a careful balance between clinical judgment and the appropriate use of diagnostic modalities. Laboratory testing is not typically necessary for children presenting with isolated facial fractures in the absence of intracranial involvement or systemic injury. However, when operative intervention is anticipated, laboratory work-up may be conducted in line with institutional preoperative requirements. These assessments may include complete blood counts, coagulation profiles, and electrolyte panels, particularly when significant blood loss, multisystem trauma, or surgical anesthesia is under consideration. The decision to pursue laboratory testing should therefore be tailored to the individual patient's clinical status rather than applied routinely. Imaging plays a central role in the diagnosis and characterization of facial fractures. Computed tomography (CT) remains the gold standard across all age groups for its superior sensitivity and specificity in detecting fractures, particularly those involving the midface, orbit, and mandible. The ability of CT to provide three-dimensional reconstructions offers a clear advantage for surgical planning and facilitates interdisciplinary communication among surgeons, radiologists, and anesthesiologists. Despite concerns regarding ionizing radiation exposure in children, CT use is justified when significant facial trauma is suspected, and imaging outcomes directly influence treatment strategies. Radiation-reduction protocols and the use of limited scanning fields help mitigate long-term risks while preserving diagnostic accuracy [25].

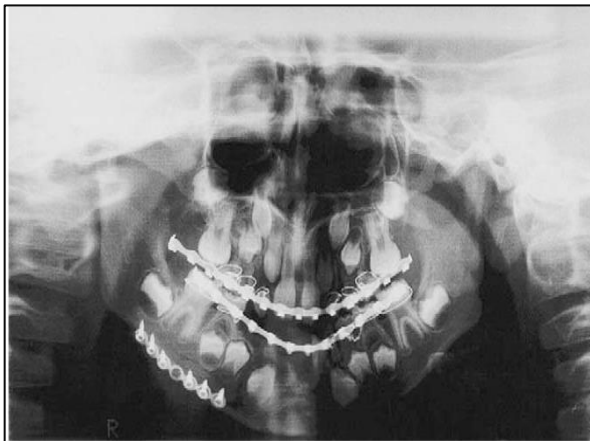


Figure-2: Imaging of Pediatric Facial Fractures.

Magnetic resonance imaging (MRI), though highly valuable in evaluating soft tissue, vascular, and neural structures, is not a primary imaging modality for assessing fractures. MRI lacks the spatial resolution to detect subtle cortical disruptions or fine fracture lines, making it unsuitable for initial evaluation. Its role is secondary and typically arises

when soft-tissue entrapment, optic nerve compromise, or suspected intracranial extension necessitate detailed soft tissue visualization. Similarly, plain radiographs and panoramic x-rays retain limited utility, primarily in dental evaluations and orthodontic planning, but they do not reliably capture the complexity of facial fractures in children. Importantly, isolated soft tissue injuries rarely benefit from imaging, as clinical evaluation and wound assessment guide their management. Furthermore, isolated nasal fractures in children, which often present with swelling, epistaxis, and deformity, do not require radiographic confirmation. These injuries are best managed based on clinical findings, with empiric treatment addressing airway patency, cosmesis, and functional outcomes. Avoiding unnecessary imaging in these cases also prevents needless radiation exposure and resource use. Overall, the evaluation of pediatric facial trauma should follow a structured, evidence-based approach. Clinical examination provides the foundation for identifying potential fractures, while CT scanning serves as the diagnostic cornerstone for suspected bony injuries. Adjunctive imaging and laboratory tests are reserved for specific indications, ensuring that children are not subjected to unnecessary interventions while enabling timely and accurate diagnosis for those requiring surgical or multidisciplinary management. This selective approach optimizes outcomes while respecting the unique vulnerabilities of the pediatric population [25].

Treatment / Management

Initial management of pediatric facial fractures begins with stabilization in accordance with Advanced Trauma Life Support principles, with priority given to airway, breathing, circulation, disability, and exposure. Severe hemorrhage, airway compromise from tongue retrodisplacement or expanding hematoma, and signs of cardiorespiratory arrest mandate immediate resuscitative measures and rapid coordination with anesthesiology and trauma surgery teams. While life- and limb-saving measures proceed, simultaneous efforts to control hemorrhage and protect exposed wounds reduce secondary injury and prepare the child for definitive assessment. Once the patient is physiologically stable, attention shifts to targeted facial assessment and the engagement of pediatric facial surgery specialists, ophthalmology, neurosurgery, and other relevant services to delineate priorities and timing of intervention. Analgesia and anxiolysis are central to initial care and permit more complete examination and imaging. Nonopioid analgesics such as acetaminophen and nonsteroidal anti-inflammatory drugs provide baseline pain control, while appropriately dosed opioids are often required for moderate to severe pain. Nonpharmacologic measures, parental presence, and age-appropriate distraction reduce distress and may obviate deeper sedation for minor procedures. When procedural sedation or local anesthesia is necessary, nitrous oxide and topical anesthetic mixtures facilitate wound

exploration and repair without traumatic intravenous access in many children [26][28]. Intranasal administration of fentanyl, ketamine, or midazolam offers an effective route when intravenous access is problematic [27].

Wound care and infection prophylaxis require assessment of contamination, sinus or oral communication, and devitalized tissue. Tetanus immunization status must be verified and updated when indicated. Evidence does not demonstrate a clear mortality or major complication benefit from routine antibiotic use in closed facial fractures; however, antibiotics are commonly administered for open fractures, contaminated wounds, animal bites, and injuries that breach the oral or sinus mucosa. Empiric regimens that cover oral flora, such as amoxicillin-clavulanate or clindamycin, are appropriate for contaminated intraoral wounds while culture-directed therapy should guide treatment for severe infections [29][30]. Imaging guides definitive management. Low-dose computed tomography with three-dimensional reconstruction is the standard for complex or suspected displaced fractures, orbital involvement, or skull base extension. Plain radiography and panoramic dental films retain roles for selected dental injuries but lack the sensitivity for midfacial and orbital assessment. Imaging results, combined with clinical findings of occlusal disturbance, step-offs, crepitus, sensory changes, extraocular muscle entrapment, or persistent diplopia, inform the need for operative intervention versus conservative care. Conservative management is appropriate for many pediatric facial fractures because of the high remodeling potential in children and the protective effect of a thick periosteum. Nondisplaced or minimally displaced fractures frequently heal with observation, short periods of immobilization, soft diet, and close follow-up with serial clinical and radiologic assessment. Orthodontic and dental interventions can address occlusal derangements without open reduction in selected cases, and splinting of alveolar fractures or dental arch stabilization may be achieved with acrylic or wire techniques in coordination with pediatric dental specialists [2][9].

Indications for operative treatment include airway compromise, ocular entrapment with oculocardiac reflex or persistent muscle dysfunction, open fractures with bone loss or gross contamination, fractures producing significant cosmetic deformity, and fractures that threaten function or will not remodel adequately with growth. Timing of surgery is individualized; urgent intervention is required for entrapment, expanding hematoma, or exposed bone, whereas delayed repair may be preferred to allow edema to subside and facilitate accurate anatomic reduction in many midface injuries. When internal fixation is necessary, surgical technique must account for growth. Resorbable fixation systems composed of polylactic or polyglycolic polymers are widely used

for non-load-bearing sites to minimize long-term interference with facial growth; however, some surgeons prefer titanium in specific scenarios where greater rigidity is required, accepting potential trade-offs in growth disturbance risk [31]. Fixation strategies favor minimal dissection, periosteal preservation, and the smallest effective implants consistent with stable reduction. Mandibular fractures in children often involve the condyle and commonly occur at two sites; detection of one mandibular fracture should prompt a search for a contralateral lesion. Condylar fractures bear special consideration because they may disturb mandibular growth centers. Closed management with functional therapy, soft diet, and early mobilization is effective for many pediatric condylar fractures, while ORIF is reserved for displaced fractures that impair occlusion or produce persistent dysfunction. Dental injuries require prompt coordination with pediatric dentistry for tooth stabilization, reimplantation when indicated, and long-term monitoring of tooth development and vitality. Orbital blowout fractures in children often present as “white-eyed” injuries with minimal external signs but with muscle entrapment leading to restricted extraocular motion, nausea, syncope, or bradycardia from the oculocardiac reflex. These presentations demand urgent surgical release to free incarcerated tissue and preserve extraocular muscle function and vision. Collaborative care with ophthalmology ensures protection of globe integrity and coordination of timing relative to fracture repair [31].

Postoperative care focuses on pain control, infection prevention, nutrition, and early rehabilitation. Early mobilization of the mandible facilitates functional recovery and reduces the risk of ankylosis. Speech and feeding support are critical for young children, and appropriate caloric management mitigates catabolic stress during healing. Long-term surveillance addresses growth disturbance, facial asymmetry, dental malocclusion, and temporomandibular joint sequelae. Regular follow-up visits with clinical examination and selective imaging allow detection of late deformities that may require secondary reconstructive procedures timed to minimize impact on facial growth. Psychosocial support, including involvement of child life specialists and mental health services, is an integral component of comprehensive care, particularly when injuries result from interpersonal violence or suspected nonaccidental trauma. Mandatory reporting and involvement of social work and protective services are required when abuse is suspected. Coordination with school and family resources supports reintegration and addresses functional or psychological consequences [31]. Multidisciplinary coordination optimizes outcomes. Early engagement of pediatric trauma surgery, oral and maxillofacial surgery, otolaryngology, plastic surgery, ophthalmology, anesthesia, pediatrics, nursing, and allied health

professionals ensures that airway, neurologic, ocular, dental, and psychosocial needs are addressed in a timely, child-centered manner. Documentation of baseline neurologic and functional status, clear operative planning that respects ongoing facial growth, and structured long-term follow-up form the foundation of high-quality care for children with facial fractures [31].

Frontal Bone Fractures

Frontal bone fractures in the pediatric population are uncommon before the frontal sinuses have undergone substantial pneumatization, a process that typically begins at approximately five to six years of age. The timing of sinus development materially influences both the incidence and the clinical consequences of frontal trauma. In younger children, the frontal bone remains relatively thick and less pneumatized, so direct frontal impacts more often transmit force to the cranial vault than produce isolated frontal sinus fractures. As pneumatization progresses, the frontal sinus becomes a potential site of fracture and of subsequent complications that require specific surgical strategies. When frontal sinus fractures occur in older children and adolescents, management decisions must balance immediate anatomic restoration, the risk of long-term sequelae such as mucocele formation, and the potential for subsequent craniofacial growth disturbance. In cases of substantial displacement or deformity that threaten cosmesis or function, reduction and rigid fixation are appropriate; conversely, modest deformities in younger patients may be amenable to conservative management because pediatric remodeling can mitigate residual contour abnormalities over time. One of the critical concerns following frontal sinus fractures is the preservation or restoration of effective nasofrontal duct drainage. Compromise of the duct predisposes to mucosal entrapment and subsequent mucocele formation, which may present months to years after the initial injury with mass effect, localized infection, or osteolysis. When the nasofrontal outflow tract is irreparably damaged or when mucosal continuity cannot be assured, obliteration of the frontal sinus after exenteration of the mucosa is a well-established technique to prevent mucocele formation. This obliteration is commonly achieved with autologous fat grafting or with a vascularized pericranial flap, the choice of which depends on defect size, patient age, and surgeon preference. These procedures are typically performed in collaboration with otolaryngology to ensure that both the cranial and sinonasal aspects of the injury are addressed. In contrast, select injuries with partial duct compromise or limited anterior table involvement may be managed conservatively with close radiologic surveillance and endoscopic follow-up, reserving obliteration for cases that demonstrate persistent drainage obstruction or mucocele development [32].

Posterior table fractures of the frontal sinus present a distinct set of management imperatives

because of their proximity to the anterior cranial fossa and the risk of cerebrospinal fluid leak, pneumocephalus, and intracranial infection. Posterior table involvement generally prompts multidisciplinary management with neurosurgery and otolaryngology. In unstable or communicative fractures of the posterior table, cranialization of the frontal sinus—removal of the posterior table and mucosa and integration of the sinus into the intracranial space—is the preferred approach, accompanied by watertight dural repair and obliteration of the nasofrontal tract to prevent future sinonasal contamination of the cranial cavity. Repair of associated cerebrospinal fluid leaks is performed concurrently, employing autologous grafts and dural sealant techniques as indicated. Surgical exposure for frontal bone fixation varies according to fracture location and size. Small inferior frontal table fractures may be accessed through limited approaches such as an upper-eyelid (supraciliary) incision, which provides aesthetic advantage through a concealed scar. However, the majority of significant frontal fractures require a coronal incision to afford adequate exposure for reduction, fixation, and sinus management. The coronal approach allows broad visualization of the frontal table, supraorbital rims, and nasofrontal region and facilitates pericranial flap harvest when obliteration or reconstruction is necessary. When open reduction and internal fixation (ORIF) are indicated, implant selection must account for patient age and growth. In non-load-bearing anterior table repairs, resorbable fixation systems can be advantageous to minimize long-term interference with growth, though in certain circumstances permanent fixation may be necessary to achieve stability [32].

Nasoorbitoethmoid complex fractures are infrequent in young children because the nasal root is less prominent relative to the rest of the midface than in adults. When nasoorbitoethmoid injury occurs, the functional and esthetic consequences can be profound, particularly if the medial canthal attachment is disrupted or the nasolacrimal system is compromised. Indications for operative intervention include traumatic telecanthus, disruption of medial canthal tendon attachment, blunting of the medial canthal angle, and shortening of the palpebral fissure. Surgical repair commonly requires a coronal exposure to allow precise anatomic reconstruction and reattachment of the medial canthal tendon to the frontal bone. When fixation of the bone segments that bear the medial canthal attachments is performed, permanent sutures or wires are often utilized to restore intercanthal distance; surgeons commonly overcorrect slightly during fixation to offset late relaxation and to minimize persistent telecanthus. Nasal fractures are the most frequent facial bone injury in adolescents and are often treated with closed reduction under general anesthesia when displacement persists or significant cosmetic deformity is present [32]. Closed reduction is typically timed to allow edema to subside but performed within a window that optimizes

realignment while minimizing the need for secondary rhinoplasty. Septal hematomas represent a true surgical urgency in pediatric nasal trauma because they threaten septal cartilage viability and can lead to septal perforation or saddle deformity if not promptly drained. In children, septoplasty is generally deferred until growth is complete due to concerns about disrupting midfacial development; corrective rhinoplasty is frequently staged to adolescence when facial growth has stabilized.

Orbital fractures in children demand particular vigilance because entrapment of extraocular muscles, most commonly the inferior rectus, may occur even in the absence of dramatic external signs. The pediatric “white-eyed” blowout fracture, characterized by minimal external bruising and edema with profound motility restriction, may present with vagal responses such as bradycardia, nausea, or syncope due to the oculocardiac reflex; these signs necessitate urgent operative release of entrapped tissue to prevent ischemia and permanent motility deficits [33][34]. When entrapment is absent, surgical timing can be elective within 24 to 48 hours, allowing edema to resolve for improved visualization while still addressing defects that exceed a threshold for reconstruction. Common indications for orbital reconstruction include defects exceeding 1 cm², involvement of more than half of the orbital floor surface, or enophthalmos greater than 2 mm on clinical or computed tomography assessment. Implant materials vary and include porous polyethylene, titanium mesh, composites thereof, resorbable polymers such as polydioxanone sheets for temporary support, and autologous split calvarial bone grafts in settings where alloplastic materials are not available or advisable. Surgical approaches to the orbital floor include transconjunctival and subciliary incisions, and intraoperative forced duction testing is essential to verify release of entrapment and to confirm uninhibited globe movement after reconstruction. Postoperative imaging confirms implant position and facilitates early detection of residual defects [33][34].

Zygomaticomaxillary complex fractures in children may be managed conservatively when displacement is minimal and function is preserved, recognizing the robust remodeling capacity of the pediatric skeleton. When reduction is indicated to correct contour deformity, restore zygomaticomaxillary buttress integrity, or relieve impingement on the ocular or masticatory apparatus, surgical access is tailored to the component of the complex requiring manipulation. The zygomaticofrontal suture is accessible via a lateral brow incision, the infraorbital rim via a transconjunctival or subciliary approach, and the maxillary buttress through an upper gingivolabial sulcus incision. Depressed zygomatic arch segments may be elevated through temporal or intraoral (Gillies or Keen) approaches. Fixation in pediatric zygomatic

fractures should be monocortical when screws are used, especially near developing tooth buds, to avoid injuring unerupted dentition [35]. Mandibular fractures in children require treatment strategies informed by dentition stage and growth considerations [36]. Many pediatric mandibular fractures, including condylar injuries, are amenable to conservative management with soft diet, analgesia, functional therapy, and limited-duration maxillomandibular fixation when necessary, because of the condyle’s capacity for remodeling. When rigid fixation is required, monocortical screws are preferred to minimize damage to developing tooth roots and to reduce the burden of hardware on growing bone. Maxillomandibular fixation in children is applied for shorter durations—commonly two to three weeks—to reduce the risk of temporomandibular joint ankylosis. In edentulous or very young patients, specialized methods such as circummandibular wiring or use of splints anchored via piriform aperture wiring may be employed. Indications for operative intervention include fractures that produce significant displacement with occlusal disturbance, bilateral fractures that reduce mandibular height and produce an open bite, mobile anterior segments, and alveolar disruptions that require stabilization for dental preservation. When malocclusion persists after fracture healing, coordinated orthodontic management may be required to restore dental alignment [37].

Postinjury management includes pragmatic guidance about diet and medications. Patients with maxillary or mandibular injuries should follow a soft or liquid diet to minimize masticatory stress on healing segments; caregivers must be counseled about using liquid-form preparations when necessary and avoiding extremes of food temperature that may provoke discomfort. Injuries involving the paranasal sinuses mandate counseling to avoid nose-blowing, forceful Valsalva maneuvers, drinking through straws, strenuous exertion, and swimming during the acute healing phase to prevent sinonasal complications. Follow-up care is integral and should be coordinated with pediatric facial surgeons and dental specialists. Early outpatient reassessment within one week is reasonable for stable patients, with more urgent review when occlusal disturbance, ocular symptoms, or neurologic concerns are present. Provision of emergency department images and reports to outpatient teams minimizes redundant imaging and reduces cumulative radiation exposure. Longitudinal surveillance extends beyond the immediate healing period because growth disturbance, malocclusion, facial asymmetry, and temporomandibular dysfunction can emerge months to years after the initial trauma; therefore, structured follow-up pathways that include clinical assessment and targeted imaging at appropriate intervals are essential to identify and address late sequelae in a timely manner [37].

Differential Diagnosis

Facial fractures in children are rare compared to adults because of the relative elasticity of pediatric bone and the protective effect of a fuller midface and developing dentition. However, when fractures do occur, they usually result from high-energy trauma and are frequently associated with multisystem injuries. Establishing a comprehensive differential diagnosis is critical for both immediate stabilization and long-term recovery. Airway obstruction from facial collapse or swelling and neurological compromise from concomitant cranial injury remain the two most urgent considerations during evaluation. A systematic approach to differential diagnosis should encompass possible bony, soft tissue, ocular, neurovascular, and associated systemic injuries.

Etiological Considerations

When assessing pediatric facial fractures, the clinician must consider underlying causes beyond accidental trauma. Nonaccidental trauma, including child abuse or neglect, is an important differential consideration and must be evaluated carefully, particularly in infants and toddlers where the mechanism of injury may be inconsistent with the history provided. Assault, whether physical or sexual, also represents a significant cause and should trigger a careful forensic and social assessment. In older children and adolescents, risk-taking behaviors such as cycling or skateboarding without helmets, sports-related injuries, and motor vehicle crashes are frequent etiologies. The absence or improper use of protective equipment plays a significant role in the incidence and severity of these injuries. Finally, intentional self-injury, including suicide attempts, must not be overlooked in adolescents presenting with facial trauma, especially when mechanisms such as falls from height or firearm-related injuries are involved.

Bony Injuries

Among the bony pathologies to be differentiated are isolated fractures of the mandible, maxilla, zygomatic complex, and nasal bones. Mandibular dislocation is a particularly important differential because it can mimic fracture-related malocclusion and trismus but requires distinct management. Skull base fractures and cervical spine injuries may occur simultaneously with facial fractures because of force transmission and must be actively excluded with imaging. Fractures involving the paranasal sinuses raise concern for sinus obstruction, mucocele formation, and intracranial extension. The clinician must also account for cartilage injuries in structures such as the nasal septum and auricle, as disruption here may cause long-term cosmetic and functional deficits if not promptly recognized.

Dental and Intraoral Injuries

Dental injuries are highly prevalent in pediatric facial trauma and include tooth avulsions, luxations, and crown or root fractures. Alveolar ridge fractures may present with tooth mobility and are

sometimes mistaken for isolated dental injury. Intraoral lacerations, gingival contusions, and temporomandibular joint disruptions must also be assessed, as they may indicate more significant underlying fractures. Early involvement of pediatric dental specialists is essential to minimize long-term occlusal and developmental consequences.

Soft Tissue Injuries

Soft tissue trauma must be carefully differentiated from underlying skeletal injury. Lacerations and contusions may obscure deeper fractures, while penetrating injuries carry the risk of retained foreign bodies. Septal hematomas, if unrecognized, can progress to abscess formation and cartilage necrosis, ultimately producing saddle nose deformity. Auricular hematomas carry a similar risk of cartilage loss, leading to cauliflower ear deformity if untreated. Accurate differentiation between hematomas and superficial swelling is, therefore, crucial to prevent long-term deformity.

Ocular Injuries

Eye injuries represent another critical component of the differential. Trauma may result in globe rupture, retrobulbar hematoma, corneal abrasions, lens dislocation, or retinal damage. In children, orbital floor fractures may trap extraocular muscles and trigger an oculocardiac reflex manifested by bradycardia, nausea, or syncope. Differentiating orbital entrapment from simple periorbital edema is vital because delayed recognition may result in permanent vision or motility deficits. Consultation with pediatric ophthalmology should be pursued in all cases of suspected ocular injury.

Ductal, Glandular, and Neurovascular Injuries

Trauma to salivary ducts or glands, such as the parotid or submandibular glands, can complicate wound healing and cause chronic salivary leakage or obstruction. Similarly, lacrimal duct injuries may accompany naso-orbitoethmoid fractures and require early repair to prevent chronic epiphora. Vascular injuries, including carotid or jugular involvement, may present with expanding hematomas, pulsatile bleeding, or neurological sequelae. Nerve injuries, particularly to the facial or trigeminal nerves, must also be assessed during examination, as these may profoundly affect function and quality of life.

Clinical Implications

Proper differentiation of these injuries significantly affects both immediate management and long-term outcomes. Early recognition of airway compromise or intracranial extension prevents life-threatening complications. Identifying occult dental, ocular, or neurovascular injuries allows timely referral to subspecialists and minimizes the risk of chronic pain, malocclusion, visual impairment, or cosmetic deformity. Importantly, recognizing nonaccidental trauma ensures that children are protected from ongoing harm while receiving appropriate medical care. In summary, the differential diagnosis for pediatric facial fractures extends beyond bony

disruption to include airway compromise, neurological injury, dental trauma, ocular pathology, ductal and glandular disruption, and soft tissue complications. A systematic, multidisciplinary approach involving radiology, pediatric dentistry, ophthalmology, otolaryngology, and neurosurgery ensures that all potential diagnoses are evaluated and managed effectively, maximizing functional recovery while minimizing aesthetic and developmental sequelae.

Prognosis

The prognosis for pediatric facial fractures is generally favorable. The pediatric craniofacial skeleton demonstrates robust biological potential for remodeling. Incomplete or minimally displaced fractures commonly realign with growth. Most children recover functional mastication, speech, and ocular motility with conservative care. Pain and swelling resolve predictably. Long-term conspicuous deformity is uncommon when injuries are recognized and managed appropriately. Nonetheless, extensive injuries confer measurable risk for persistent morbidity. Fractures that disrupt growth centers, such as condylar or naso-orbitoethmoid injuries, may produce progressive asymmetry. Significant comminution, crushing, or loss of bone may not remodel adequately and can lead to contour deformity that requires secondary reconstructive surgery timed to skeletal maturity. Infection after sinus or dental involvement, retained foreign bodies, or grossly contaminated wounds can compromise healing and worsen aesthetic and functional outcomes. Dental sequelae are frequent when the dentoalveolar complex is involved. Tooth loss, arrested root formation, or altered eruption of successor teeth portend long-term orthodontic and prosthetic needs. Visual prognosis depends on the timeliness of recognition and intervention for orbital and globe injuries. Extraocular muscle entrapment warrants urgent release to prevent ischemic muscle injury and fibrosis. Delays in addressing entrapment correlate with persistent diplopia and restricted gaze, and they increase the likelihood of permanent visual dysfunction. Similarly, optic nerve compromise from compressive hematoma or direct injury requires immediate ophthalmologic and neurosurgical collaboration to optimize the chance of visual recovery [38].

Complications:

Neurologic and neurovascular complications also determine outcome. Frontal bone fractures that communicate with the anterior cranial fossa increase the risk for cerebrospinal fluid leak, meningitis, and intracranial infection. Early multidisciplinary management and, when indicated, cranialization reduce these risks and improve long-term neurologic prognosis. Facial nerve injuries sustained at the time of trauma or during repair can produce persistent motor deficits. Early identification, appropriate timing

of repair, and rehabilitation influence functional recovery but do not guarantee full restitution.

Outcomes:

Psychosocial outcomes merit explicit attention. Facial injuries may alter appearance and function during critical developmental periods. Children and adolescents may experience body-image disturbance, social withdrawal, or academic disruption. Early psychosocial screening, counseling, and, when indicated, referral to child psychology or psychiatry mitigate these effects and improve adaptation. Longitudinal follow-up that incorporates psychosocial assessment is therefore an essential component of comprehensive care. Prevention and patient education directly affect population-level prognosis. Interventions that reduce mechanism severity—seat belts and age-appropriate restraints in motor vehicles, helmets with facial protection for high-risk sports and recreational activities, and community measures to limit interpersonal violence—contribute to fewer severe injuries and improved aggregate outcomes. Counseling caregivers about safe play environments, supervision, and the use of protective equipment is effective and should be integrated into discharge planning and outpatient visits [38][39][40][41]. Timely assessment and accurate diagnosis optimize the individual prognosis by enabling appropriate early interventions. Prompt imaging when indicated, early specialist consultation, and institution of airway, ocular, and dental protections prevent secondary injury. Antibiotic stewardship for contaminated wounds and appropriate tetanus prophylaxis reduce infectious complications. When operative repair is necessary, techniques that minimize interference with growth—such as limited exposure, periosteal preservation, monocortical fixation, and use of resorbable materials when appropriate—improve long-term facial development while providing necessary stability for healing. Complications that alter prognosis include growth disturbance with resultant long-term disfigurement, infection particularly with sinus or dental involvement or retained foreign material, adverse dental outcomes, persistent sensory or motor nerve deficits, chronic or posttraumatic facial pain, and prolonged visual compromise when orbital injuries are not promptly managed. Early recognition of these risks and proactive measures to address them—surgical, medical, and rehabilitative—are central to preserving function and appearance [38][39][40][41].

Healthcare Roles:

The role of multidisciplinary care in shaping prognosis cannot be overstated. Coordinated management involving pediatric trauma surgery, oral and maxillofacial surgery, otolaryngology, ophthalmology, pediatric dentistry, neurosurgery, anesthesia, nursing, and allied rehabilitation professionals ensures that lifesaving priorities and long-term functional goals are balanced. Structured

referral pathways and standardized follow-up protocols improve detection of late sequelae and permit timely secondary interventions. Clear discharge instructions, provision of imaging and operative reports to outpatient providers, and scheduling of early specialist follow-up reinforce continuity of care and reduce the likelihood of overlooked complications. In summary, pediatric facial fractures most often heal with favorable functional outcomes owing to the unique reparative capacity of the growing skeleton. Yet a subset of injuries carries risk for permanent deformity, sensory or motor deficits, visual loss, dental compromise, infection, chronic pain, and psychosocial impact. Prognosis improves with early, accurate diagnosis; judicious use of imaging; timely multidisciplinary intervention that respects growth potential; meticulous operative technique when required; and proactive preventive education. Structured long-term surveillance is necessary to identify and address evolving growth-related sequelae and to optimize the child's functional and psychosocial recovery.

Conclusion:

Pediatric facial fractures present a unique clinical challenge due to the dynamic anatomy and developmental considerations of the growing craniofacial skeleton. While the incidence is lower than in adults, the potential for long-term functional, aesthetic, and psychosocial consequences necessitates a careful, multidisciplinary approach. Early recognition, accurate imaging, and age-appropriate management strategies are essential to optimize outcomes. Conservative treatment is often sufficient for minimally displaced fractures, leveraging the high remodeling capacity of pediatric bone. However, surgical intervention becomes necessary when fractures threaten airway patency, ocular function, occlusion, or facial symmetry. The role of dental specialists is critical in managing dentoalveolar injuries and preserving occlusion and tooth vitality. Imaging modalities, particularly low-dose CT with 3D reconstruction, enhance diagnostic precision while minimizing radiation exposure. Long-term follow-up is vital to monitor growth disturbances, malocclusion, and temporomandibular dysfunction. Psychosocial support and preventive education further contribute to holistic recovery and reduce recurrence risk. Ultimately, successful management of pediatric facial fractures depends on timely diagnosis, coordinated multidisciplinary care, and structured surveillance. By integrating surgical, dental, radiologic, nursing, and psychosocial expertise, healthcare providers can ensure both immediate stabilization and long-term developmental preservation for affected children.

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