Rigid Fixation of the Pediatric Facial Skeleton

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KEYWORDS

- Rigid fixation • Internal fixation • Resorbable hardware • Nonresorbable hardware
- Craniofacial growth

KEY POINTS

- Pediatric facial fractures do not often require internal fixation. Conservative management or closed reduction can be used for many situations.
- Internal fixation in children less than 10 years of age is complicated by the presence of reduced bone stock and permanent tooth buds.
- Nonresorbable hardware has superior mechanical properties; however, there are concerns associated with implant size, implant strength, translocation, and, less so, growth restriction.
- Resorbable hardware obviates elective removal and is a reasonable alternative to traditional titanium implants in non–load-bearing regions.

INTRODUCTION

Pediatric patients are distinct from adults. Children exhibit different facial fracture patterns; their bones are incompletely ossified; their dentition is constantly evolving; and their skeleton is actively growing. Furthermore, when considering pediatric care, the social concerns of both patients and their families may affect the timing and type of treatment rendered. Pediatric facial fractures are uncommon. Fortunately, the majority of these injuries are amenable to conservative management and do not require internal fixation. Due to ongoing growth considerations, many providers elect to avoid internal skeletal fixation in children whenever possible. Persistent plates and screws can potentially tether bony fragments and mechanically inhibit normal facial growth. It is important to recognize that hardware itself is not the sole culprit. Experiences borrowed from cleft surgery have demonstrated that there are multiple contributions to craniomaxillofacial growth restriction.[1] Simple periosteal elevation disrupts the vascularity and the nutritional state of bone. Wound contracture and scar formation, which are part of normal healing, are well-described risk factors for subsequent bony hypoplasia. Furthermore, fractures or osteotomies can directly disrupt ossification centers. Even in the presence of these iatrogenic disturbances, growth is rarely arrested. As such, orthognathic surgery must be delayed until after adolescence to avoid skeletal relapse. It is difficult to parse out the contribution of each individual risk factor to growth restriction. This has led to uncertainty regarding the precise role that hardware fixation plays in altering pediatric craniofacial growth, with some arguing that internal fixation plays a minimal role in inhibiting normal bone formation.[2] Regardless, within many disciplines, there is hesitancy and preference against internal fixation in pediatric patients. The goal of this article is to present the principles of pediatric rigid fixation and to discuss the merits of nonresorbable and resorbable hardware options.

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PRINCIPLES OF RIGID FIXATION

Fracture immobilization is required to achieve bony union.[3] Primary bone healing occurs when precise anatomic reduction allows for direct lamellar contact. Once the defect is narrowed, osteogenic elements are then able to traverse the fracture line and restore continuity. If there is misalignment or movement across a fracture, the body will form a bony callus in an attempt to bridge and/or stabilize the bony segments (**Fig. 1**). Excessive gaps or movement can overwhelm the body's ability to heal secondarily and therefore increase the risk of fibrous or nonunion.

The concept of rigid fixation first originated in the orthopedic literature but was subsequently adapted for use in craniomaxillofacial surgery. Rigid fixation achieves complete immobility across a fracture such that there is no micromovement during function. In contrast, nonrigid fixation lacks sufficient strength to entirely prevent movement of bone fragments under function. Although rigid fixation is the preferred treatment strategy, the body can still achieve bony union with nonrigid fixation through secondary healing. Of note, when comparing fixation techniques, some surgeons will consider rigidity on a spectrum rather than as an all-or-none event. In this context, techniques that are better at reducing interfragmentary motion are considered to be "more rigid." The concept of rigid versus nonrigid fixation should not to be confused with the concept of load bearing and load sharing, the latter of which are properties inherent to the hardware that is used. With load-bearing fixation (reconstruction plate), the hardware absorbs all of the external force, whereas with load-sharing fixation (miniplate), the external force is distributed between both the hardware and the underlying bone. Load-bearing fixation is always rigid; however, load-sharing fixation may be either rigid or nonrigid depending on how it is applied.

Because the mandible is subject to both muscular and occlusal forces, the principles of rigid fixation are particularly important in the management of mandibular fractures. The upper and midface are not subject to the same functional loads, and therefore fixation strength poses less of a concern in those regions. Before the advent of modern skeletal fixation, closed reduction with maxillomandibular fixation (MMF) was the mainstay of treatment of mandible fractures. When situations were not amenable to MMF, external pins were used for rigid stabilization. Intraosseous wiring was helpful for aligning and reducing the bony segments; however, this technique was only semirigid and lacked sufficient strength to be used by itself in the mandible. Despite these and other early efforts at internal fixation, the end result always lacked sufficient rigidity. MMF was therefore still required as an adjunct to immobilize the fracture and eliminate masticatory forces. The first attempts at plate and screw fixation were met with high rates of failure because surgeons at the time did not respect the biomechanics of the mandible. In 1978, Maxime Champy published his ideal zones of osteosyntheses for load-sharing fixation in the dentate mandible.[4–6] Champy's techniques improved treatment success by optimizing areas of compression and tension to ensure adequate rigidity across the fracture line. A Champy-style plate for mandibular angle fractures is an example of "nonrigid" or "semirigid" fixation (**Fig. 2**) that functions with success because it respects the mandibular lines of osteosynthesis (**Fig. 3**).[4–6] Ellis subsequently expanded on Champy's work and proposed his own decision algorithm for managing non–condylar mandible fractures that incorporated both closed and open reduction.[7] This algorithm can be applied to pediatric fractures as well.

Pediatric craniomaxillofacial fractures are subject to the same treatment principles as adult fractures. Namely, the mandible preserves its role as a load-bearing bone, and therefore, any treatment

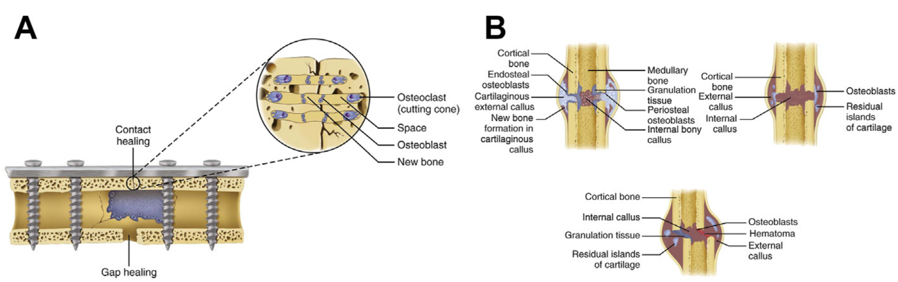

Fig. 1. Bone healing can occur (*A*) primarily when bone segments are in direct contact with no interfragmentary mobility or (*B*) secondarily through callus formation. (*From* Markiewicz MR, Engelstad M. Chapter 73: Principles and Biomechanics of Rigid Fixation of the Mandible. In: Tiwana PS. *Atlas of Oral and Maxillofacial Surgery*. 2nd ed. Elsevier; 2023:805-815.)

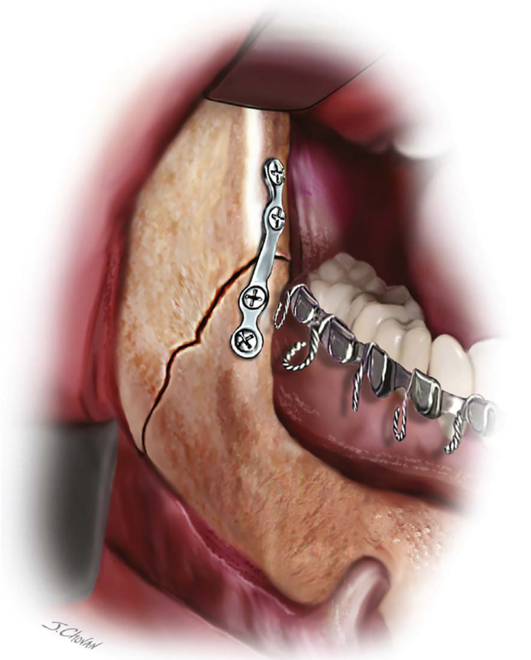

Fig. 2. The Champy technique allows for semirigid fixation of mandibular angle fractures using a miniplate with monocortical screw placement. (*From* Markiewicz MR, Engelstad M. Chapter 73: Principles and Biomechanics of Rigid Fixation of the Mandible. In: Tiwana PS. *Atlas of Oral and Maxillofacial Surgery*. 2nd ed. Elsevier; 2023:805-815.)

should incorporate the aforementioned fixation guidelines. Children do have the benefit of improved osteogenic capacity, and therefore, they can tolerate shorter durations of MMF. In fact, prolonged MMF and temporomandibular joint disuse are contraindicated because they increased the risk of ankylosis. Their superior wound healing abilities and tendency to "greenstick fracture" also present a larger opportunity for conservative management. The designation of plates as either load bearing or load sharing by manufacturers is based on the ability to resist forces applied by the adult mandible. Children have lower peak bite forces, which places less demand on the hardware. As such, plates designed to be load sharing in adults may provide sufficient strength to achieve load-bearing fixation in a child. There is also a decreased need to obtain completely rigid internal fixation in children because dental splints and other external adjuncts are often used in combination to stabilize the fracture. The effectiveness of semirigid internal fixation for pediatric patients also opens the possibility of using resorbable materials not only in the upper midface but also in the mandible.

PEDIATRIC ANATOMIC CONSIDERATIONS

Pediatric proportions exhibit a larger cranium to face ratio (8:1) than that of adults (2.5:1).[8] (**Fig. 4**). As a result, the face is relatively protected from trauma at the expense of the cranium. Pneumatized sinuses and unerupted tooth buds compromise the structural integrity of the facial skeleton.[9,10] Stereotyped patterns of injury occur based on the stage of development and the location of these breakage points.[10–12] Midface fractures are extremely uncommon in children aged younger than 6 years because of the recessed bony anatomy, thicker subcutaneous fat pads,

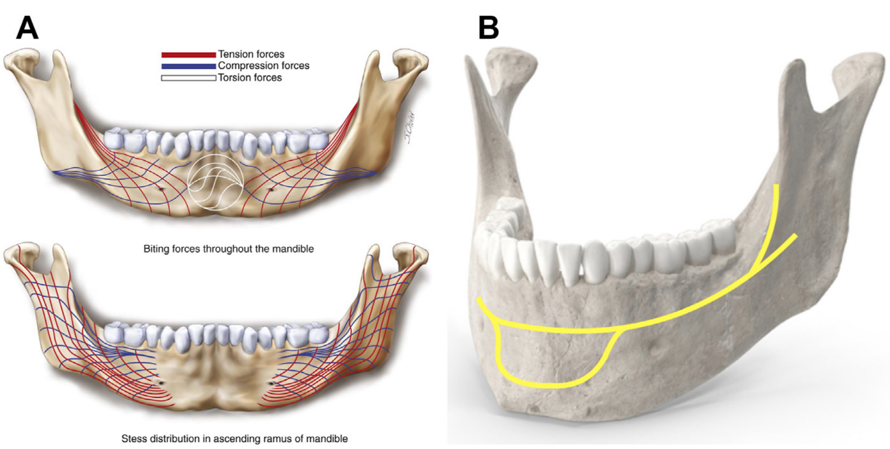

Fig. 3. (*A*) Each component of the mandible experiences various types of force during function. (*B*) The zones of osteosynthesis correspond to areas of fixation that stabilize the mandible against these forces and permit a favorable stress pattern. (*From* Markiewicz MR, Engelstad M. Chapter 73: Principles and Biomechanics of Rigid Fixation of the Mandible. In: Tiwana PS. *Atlas of Oral and Maxillofacial Surgery*. 2nd ed. Elsevier; 2023:805-815 (Figure 3A).)

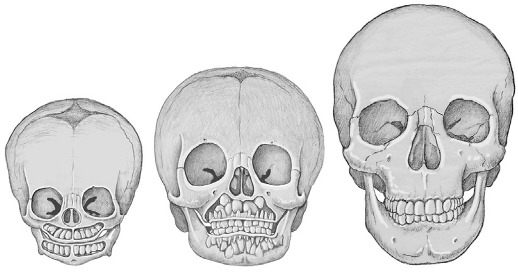

Fig. 4. The changing proportions of the craniomaxillofacial skeleton at various stages of development. (*Courtesy of* Paul Dressel, MD, Buffalo, NY; and Reprinted with permission from: Costello BJ, Rivera RD, Shand J, Mooney M. Growth and development considerations for craniomaxillofacial surgery. Oral Maxillofac Surg Clin North Am. 2012 Aug;24(3):377-96.)

and clinical irrelevance of the paranasal sinuses. The mature paranasal sinuses allow the face to absorb and dissipate forces away from the skull base.[12] The maxillary and ethmoid sinuses are present at birth and complete development sooner than the frontal and sphenoid sinuses that form postnatally. Once the maxillary sinus reaches a meaningful size, around the age of 7 years, the risk of orbital roof injury decreases and the risk of orbital floor injury increases proportionally with the extent of pneumatization. The pediatric mandible occupies a more vulnerable position in the facial skeleton than the midface and is most susceptible to fracturing at the condylar and the parasymphyseal regions.[12,13] The developing permanent mandibular canine creates a unique stress point that disappears once dental eruption and bone substitution are completed.[14]

The distinct anatomy of children also poses unique considerations for internal fixation. Most anatomic differences converge by 10 years of age, after which point many surgeons will manage both pediatric and adult patients in a more uniform fashion.[4,8] Until the eruption of the permanent second molars at 13 years, tooth buds occupy much of the intercortical volume within the mandibular body and symphysis. Even with grossly displaced fractures, bicortical fixation is generally unnecessary and relatively contraindicated during primary and mixed dentition (**Fig. 5**). Any internal fixation during this stage of development should be placed along the inferior border so that the screws are housed entirely within cortical bone. This avoids damage to the inferior alveolar nerve and the developing dentition. The pediatric maxilla is short and retruded, and before 6 years of age, much of the maxillary volume is similarly occupied by the permanent tooth buds. These maxillary tooth buds may be at risk when attempting to plate the zygomaticomaxillary (ZMC) buttress for the rare pediatric zygomatic complex fracture. In such instances, Kaban and colleagues have justified using 1-point of fixation at the zygomaticofrontal suture because of the shorter lever arm generated by the smaller zygoma.[15] Every effort should be made to ensure that any internal fixation does not traverse suture lines or the mandibular midline.[16] Multiple animal studies have demonstrated that rigid fixation across active sutures in both the skull and the face mimics premature fusion and does significantly restrict growth potential.[17,18]

NO FIXATION

As previously stated, pediatric facial fractures do not often require open reduction or fixation. Their osteogenic potential and lack of bite force allows children to naturally recover from fractures that would not normally heal on their own in adults without surgery. It is important to recognize that a nonsurgical approach is distinct from "no management" or "no follow-up." In fact, the growing child benefits from closer follow-up than the skeletally mature adult. Pediatric condylar or subcondylar fractures are prime examples of injuries that are treated nonsurgically but require longitudinal observation (**Figs. 6** and **7**). Ideally, regular surveillance is performed by a multidisciplinary team that includes an oral and maxillofacial surgeon, a pediatric dentist, and an orthodontist. The growth of the mandible and midface should be monitored and consideration should be given to early intervention with dentofacial orthopedics, occlusal equilibration, or orthodontics. Midterm and long-term follow-up may reveal the need for subsequent surgical intervention to address acquired dentofacial deformities such as open bite malocclusion or facial asymmetry.

The aforementioned characteristics of pediatric patients permit reduction and/or reconstruction without fixation in select situations. Orbital fractures with single-wall defects generally do not need fixation. The supraorbital roof fracture is an injury pattern that frequently occurs in children and is rarely seen in adults. It typically presents as a blow-in fracture of the orbital roof, and when surgery is indicated, simple manipulation and reduction of the segments is often sufficient (**Fig. 8**). Similarly, implants placed for the reconstruction of isolated orbital floor fractures, whether through a transconjunctival (**Fig. 9**) or a transantral approach (**Fig. 10**), do not usually require fixation. Finally, isolated dentoalveolar trauma that spares the remainder of the mandible does not usually

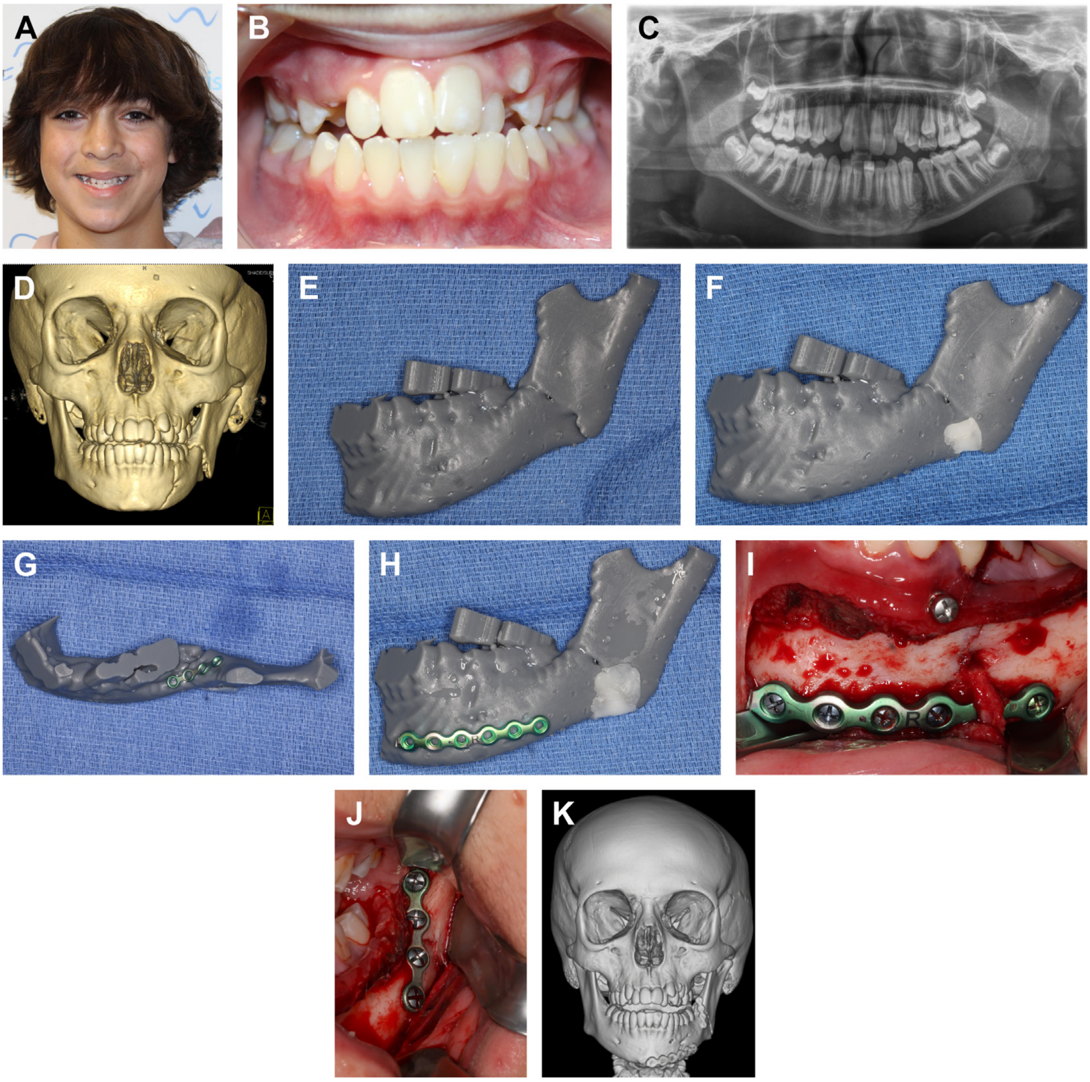

Fig. 5. Case of a 12-year-old patient who sustained a hockey puck injury to the face resulting in left mandibular symphysis and angle fractures. (*A*, *B*) Preinjury patient records obtained from orthodontist demonstrating a baseline Class 3 malocclusion. Left-sided mandible fractures demonstrated on (*C*) panoramic and (*D*) CT images. (*E*) In-house point of care printing of the left hemimandible using CT data. (*F*) Fractured segments separated and anatomically reduced. (*G*, *H*) Titanium plates prebent and adapted to the perfected model. (*I*, *J*) Excellent intraoperative fit of prebent plates confirmed without the need for additional adjustment. (*K*) Final immediate postoperative result.

require rigid fixation. Reduction into a semirigid dental splint provides sufficient stability for healing. In these situations, the senior author will often work in conjunction with a pediatric dental team to fabricate a 3-dimensionally printed occlusal splint for added rigidity (**Fig. 11**).

NONRESORBABLE FIXATION

The ideal implant has adequate strength to resist function, adequate stiffness to permit a thin profile, and adequate malleability to facilitate easy adaptation.[19] Although early manufacturers experimented with stainless steel and Vitallium (cobalt-chromium-molybdenum) alloy implants, nearly all modern fixation systems use titanium because it has excellent mechanical properties, withstands corrosion, is biocompatible, and osseointegrates with bone. Compared with commercially available resorbable materials, titanium has superior resistance to both tensile and torsional forces.[20] Titanium implants are also more compact and less

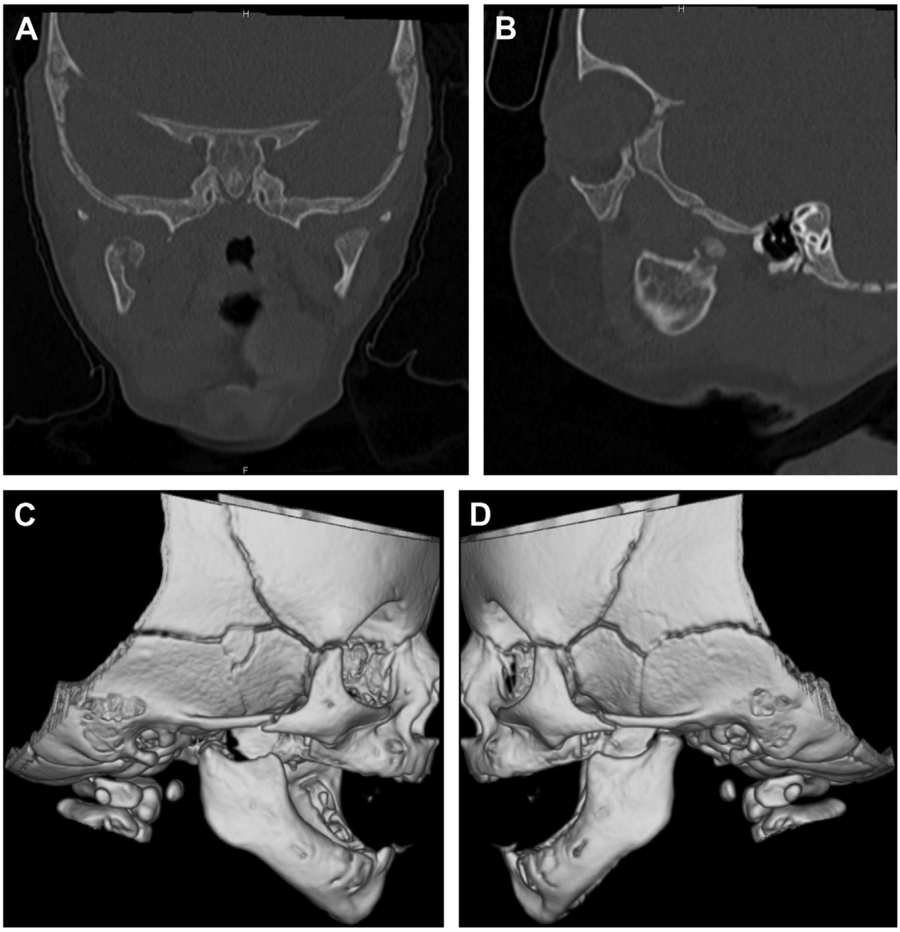

Fig. 6. Case of a condylar fracture in an infant that was managed with observation. CT of the face demonstrating medial displacement of the right condylar head on (*A*) coronal and (*B*) sagittal views. (*C, D*) Three-dimensional reconstruction of the CT scan demonstrating the loss of vertical mandibular height on the right compared with the left.

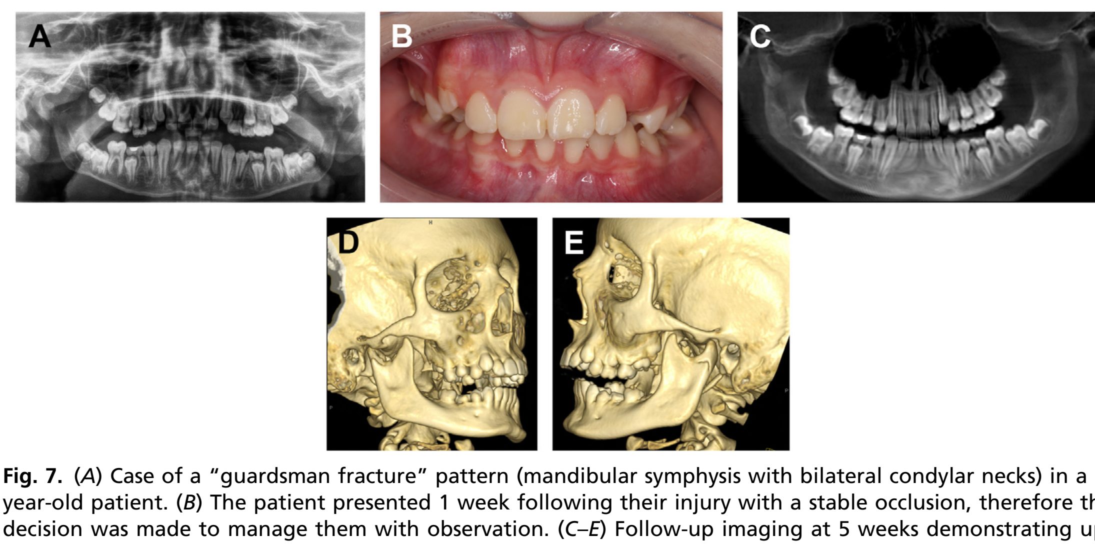

Fig. 7. (*A*) Case of a "guardsman fracture" pattern (mandibular symphysis with bilateral condylar necks) in a 7-year-old patient. (*B*) The patient presented 1 week following their injury with a stable occlusion, therefore the decision was made to manage them with observation. (*C–E*) Follow-up imaging at 5 weeks demonstrating up-righting of the displaced condyles and good secondary bone healing.

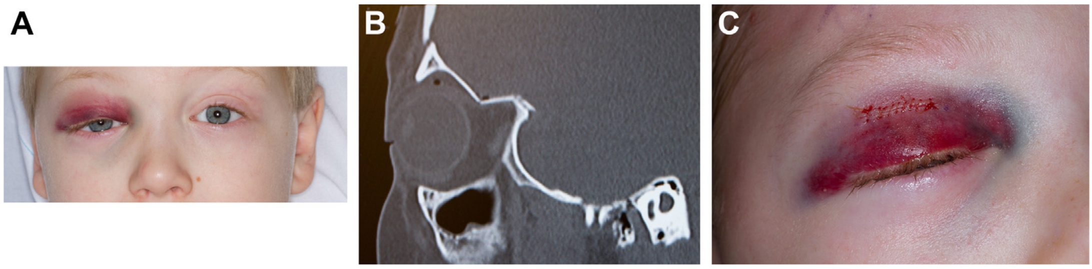

Fig. 8. Case of an 8-year-old patient who sustained an orbital roof blow-in fracture from a ball to face injury. (*A*) Preoperative photo demonstrating periorbital edema and ecchymoses with otherwise unremarkable ocular examination. (*B*) Imaging demonstrating displaced blow-in fracture pattern in the setting of a clinically absent frontal sinus and an incompletely developed maxillary sinus. (*C*) Fractured segments reduced without fixation using a periosteal elevator through an upper blepharoplasty approach.

palpable in the immediate postoperative phase. As in adults, the rigidity offered by nonresorbable fixation lowers the reliance on postoperative MMF. The ability of titanium hardware to protect the mandible from loading forces does raise the long-term concern of stress shielding, or disuse atrophy.[21] This effect is controversial and probably more of a concern with edentulous segments where there are no teeth to maintain the bone.

The inert quality of titanium permits the body to continue appositional growth around the implant. Unfortunately, this results in hardware translocation. Many surgeons who use nonresorbable plating in the growing child will perform a separate retrieval procedure between 2 and 3 months postoperatively once the implant is no longer serving its original purpose.[22] By doing this, the intent is to avoid issues associated with migration rather than address

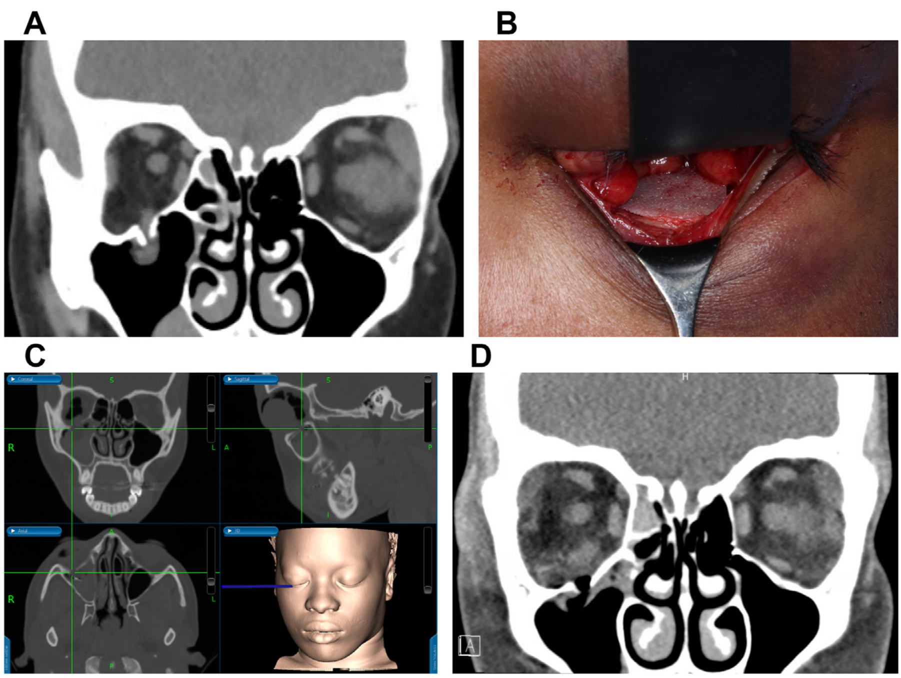

Fig. 9. Case of an isolated orbital floor fracture in a 14-year-old patient presenting with extraocular muscle entrapment. (*A*) CT coronal view demonstrating herniation of the inferior rectus into the right maxillary sinus, of note entrapment cannot be diagnosed radiographically and requires a clinical examination for confirmation. (*B*) Orbital floor reconstruction with a porous polyethylene implant placed through a transconjunctival approach without screw fixation. (*C*) Intraoperative navigation used to confirm the posterolateral seating of the orbital implant. (*D*) Postoperative imaging demonstrating reduced orbital contents. Porous polyethylene implants are radiolucent and therefore they are not visible on CT scans.

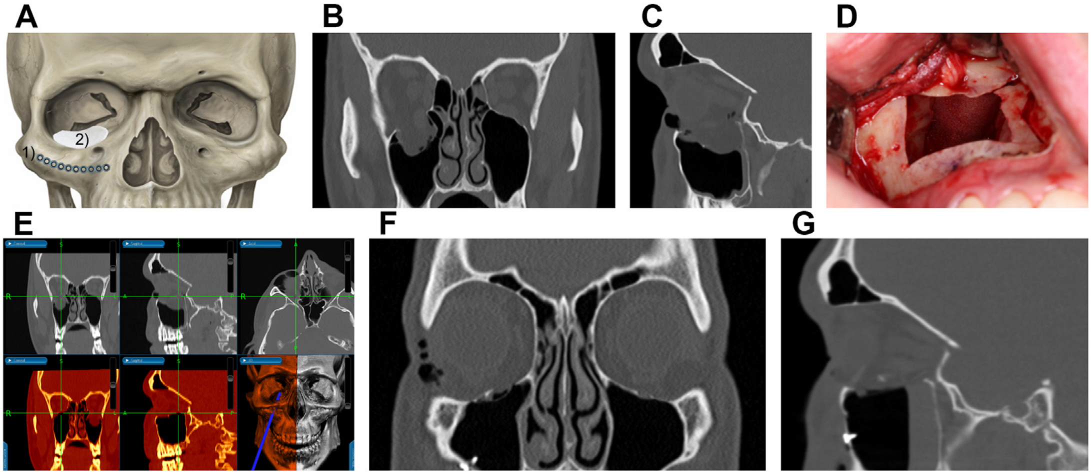

Fig. 10. Case of an isolated orbital floor fracture reconstructed through a transantral approach. (*A*) An antral window is removed from the anterior maxilla and replaced with fixation after the orbital floor implant is appropriately positioned. CT (*B*) coronal and (*C*) sagittal views demonstrating blow-out fracture of the right orbital floor. (*D*) Large maxillary antrostomy used to approach the orbit. (*E*) Intraoperative navigation used to ensure safe posterior dissection along the floor defect. (*F, G*) Postoperative imaging demonstrating reduced orbital contents and good form of the replaced anterior maxilla.

growth concerns because a second surgery itself could inflict additional scarring and growth restriction.[2,14] Furthermore, the fluid nature of bone remodeling argues against significant growth inhibition with nonresorbable hardware. When left in place, plates and screws can translocate into tooth buds or enter other body compartments, such as the intracranial space. Fortunately, there have been no documented cases of permanent brain injury from hardware migration. If the decision is made to leave the hardware in place, patients should be aware that approximately 8% of plates will ultimately require nonelective explantation due to pain or mobility.[2] Depending on the indication for removal, late retrieval of hardware can be quite difficult as the plates may be buried beneath a deep layer of healthy bone. Therefore, the removal of plates shortly after healing is recommended (Fig. 12). Hardware removal is usually no necessary in the skeletally mature patient (Fig. 13).

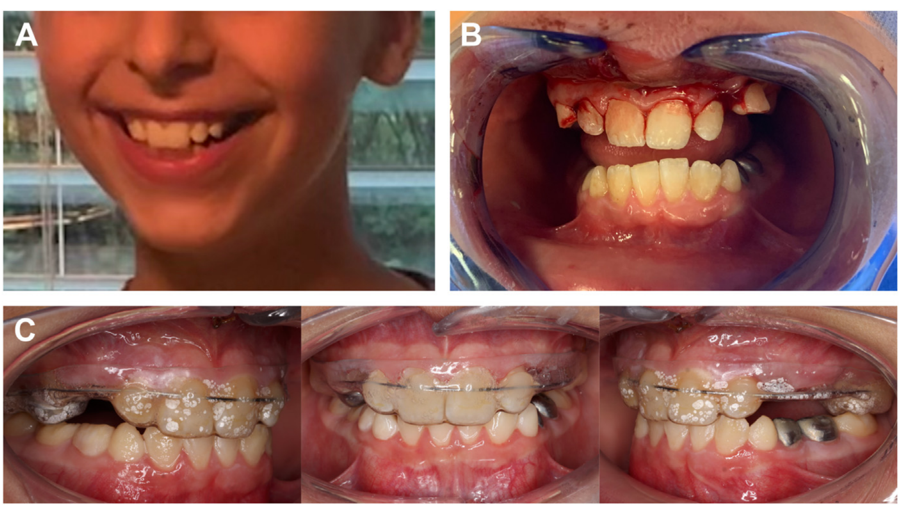

Fig. 11. Case of an isolated maxillary dentoalveolar fracture managed with closed reduction. (*A*) Preoperative photo demonstrating positive overjet. (*B*) Injury photo demonstrating edge-to-edge occlusion from palatal displacement of anterior maxillary dentition. (*C*) Postoperative result of patient after using both a semirigid wire and a custom in-house printed dental tray to splint and stabilize the maxillary dentition.

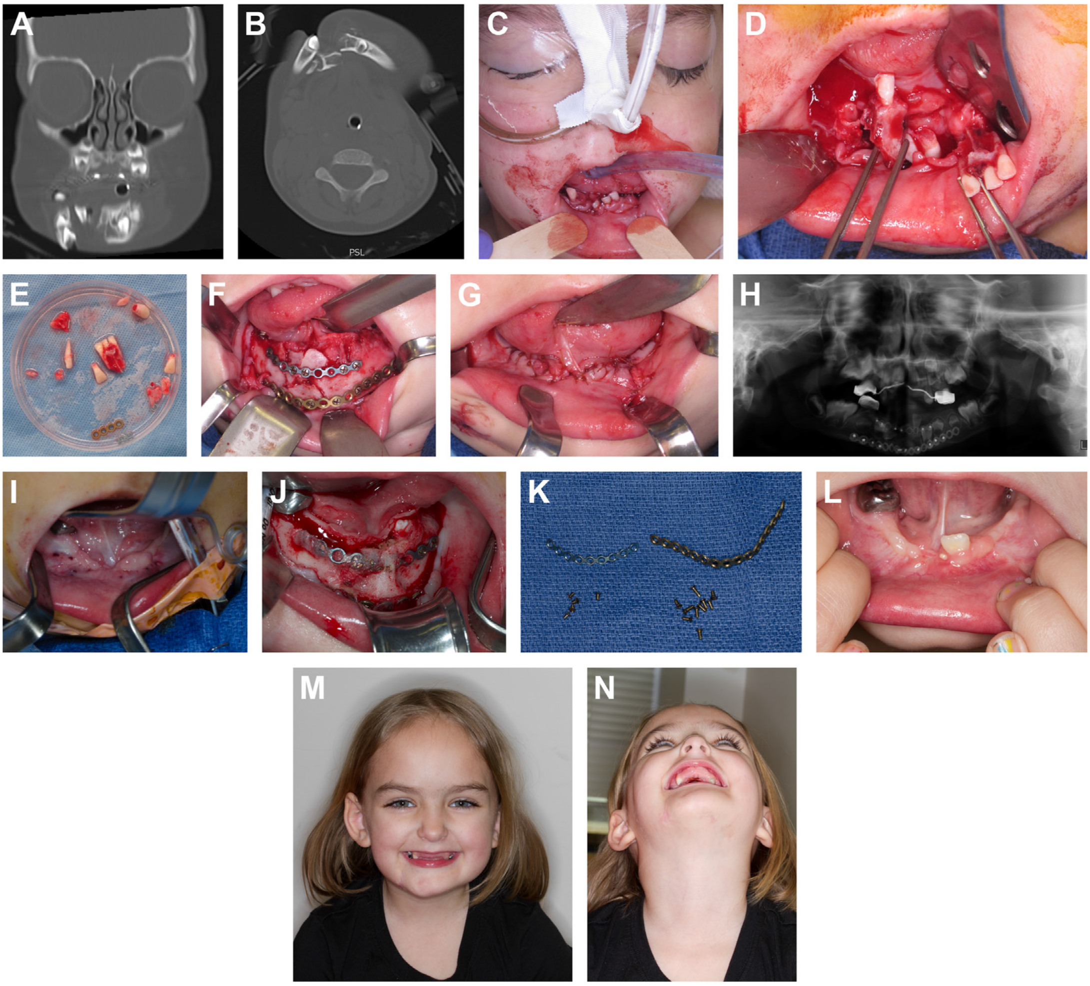

Fig. 12. Case of a 6-year-old patient who sustained a comminuted mandible fracture from an unrestrained motor vehicle accident. CT (*A*) coronal and (*B*) axial views demonstrating complex anterior mandible fracture with developing permanent dentition. (*C*) Clinical examination and (*D*, *E*) intraoperative findings significant for mobile dentition and multiple unsupported bone fragments. (*F*, *G*) Two load-sharing titanium miniplates used with monocortical screws to fixate the free-floating bone and provide rigid stabilization of the mandible. (*H*) Postoperative panoramic radiograph. Patient returned to the operating room 7 weeks later for the removal of the titanium hardware. (*I*, *J*) Exposure of the plates and screws was notable for bony overgrowth during the interval period. (*K*) Explanted hardware. (*L–N*) Three-month postoperative follow-up with good chin point symmetry and successful emergence of the permanent lateral incisor that was preserved in the zone of injury.

RESORBABLE FIXATION

The purpose of resorbable fixation is to selectively provide internal rigidity during the period of bony healing while avoiding the need for a second reentry procedure. Current resorbable materials are polymers of both polyglycolic acid (PGA) and polylactic acid (PLA). Both of these compounds are hydrolyzed into lactic acid. The lactic acid byproduct is then transported to the liver where it is metabolized into carbon dioxide and water. PGA degradation occurs more rapidly on the order of weeks to months, whereas PLA degradation takes years. Different manufacturers combine various proportions of PGA and PLA into their product so that they can obtain the desired degradation properties. Most commonly, resorbable hardware is designed to preserve its rigidity for up to 3 months and be completely resorbed by 1 to 2 years. Although titanium is radiopaque and prone to causing imaging artifact, resorbable fixation is radiolucent even if it persists beyond its intended duration.

The use of resorbable hardware is technique sensitive due to its less robust mechanical

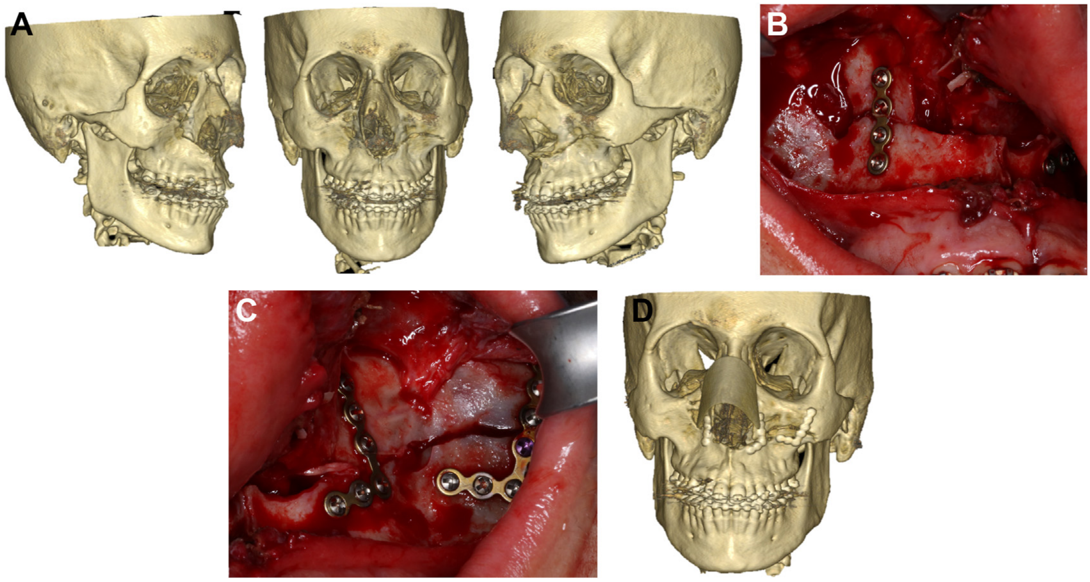

Fig. 13. Case of a bilateral Lefort II fractures with a left-sided hemi-Lefort I component in a 16-year-old patient. (*A*) Three-dimensional reconstruction of facial skeleton. (*B*, *C*) Transoral exposure of the hemi-Lefort I fracture with titanium miniplate fixation. (*D*) Postoperative imaging demonstrating reduced and fixated Lefort I fracture with closed reduction of the naso-orbito-ethmoid component of the Lefort II injury. Because of the patient's age and skeletal maturity, they were treated like an adult, and the hardware was not retrieved.

properties.[19] Titanium is malleable, and thinner plates can often be contoured in-situ. However, resorbable plates are brittle and need to be heated in warm water baths to permit adaptation. The weaker mechanical stability of PGA/PLA implants necessitates that they be manufactured to be broader and thicker than their titanium counterparts.[19] The larger footprint of resorbable fixation makes their use cumbersome (**Fig. 14**). Resorbable fixation is only intended for use in the cranium (**Fig. 15**) and midfacial skeleton (**Fig. 16**). It is not currently FDA-approved for isolated use in load-bearing situations such mandibular trauma, although some providers will combine resorbable fixation with dental splints and MMF to reduce the hardware strain.[23] As discussed previously, children have the benefit of a weaker bite force and smaller bones with shorter lever arms. Resorbable plates and screws seem to provide sufficient rigidity in most pediatric situations. Titanium fixation systems offer both self-drilling and self-tapping screw options to engage the bone and improve stability. Resorbable screws have poor torsional strength. As a result, they traditionally require both predrilling and pretapping before insertion. Even with proper site development, bioresorbable screws need to be carefully inserted because they are prone to fracturing during placement. In such instances, screw fracture is not catastrophic because the osteotomy can be

Fig. 14. Side-by-side comparison of titanium miniplates and resorbable hardware.

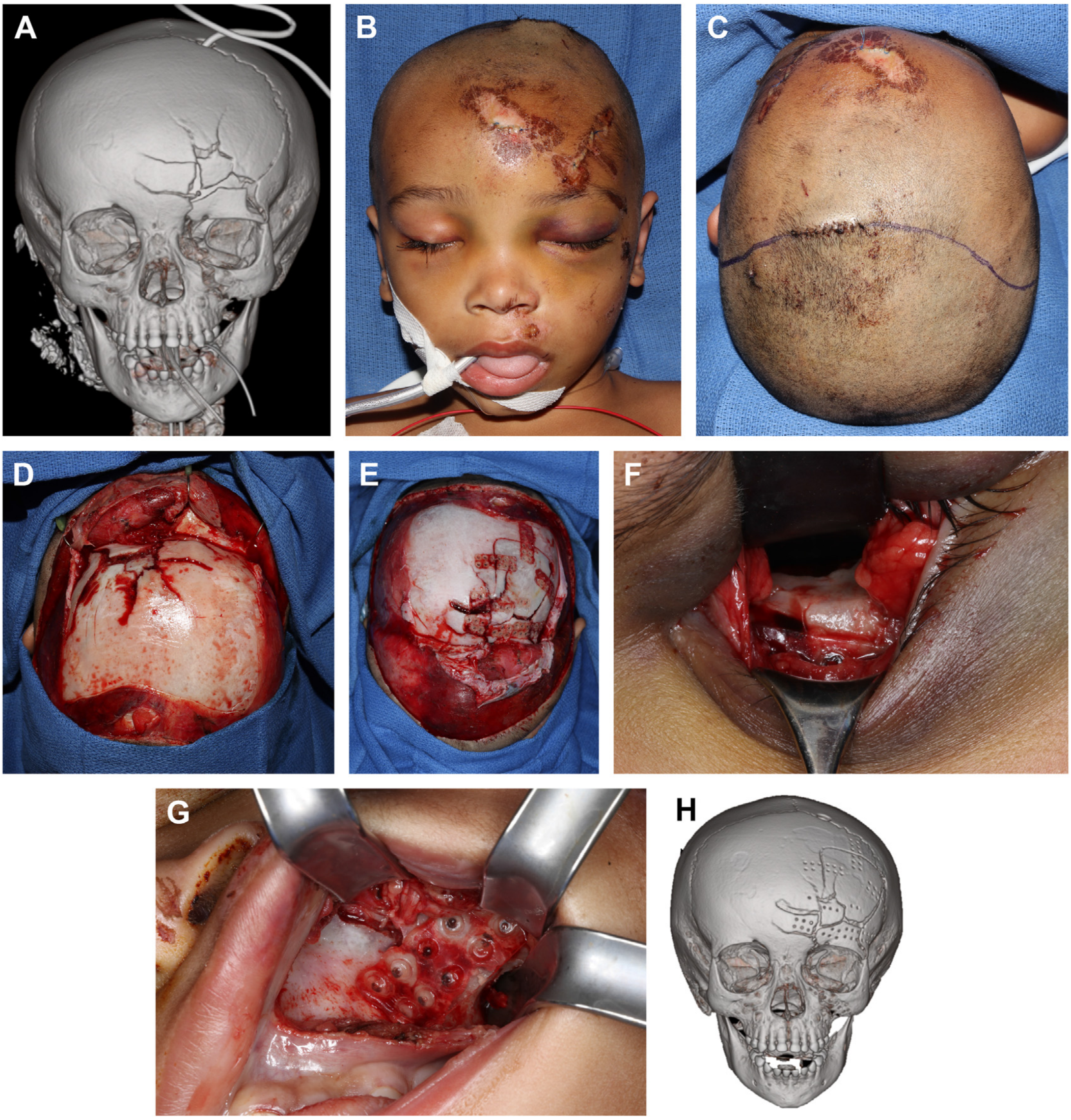

Fig. 15. Case of a 7-year-old patient who was an unrestrained passenger in a motor vehicle collision and sustained left-sided frontal bone and ZMC complex fractures. (*A*, *B*) Pattern of injury significant for orbital roof and floor components. Multiple scalp abrasions but no open laceration available for direct access to the upper and midface. (*C*) Planned bicoronal incision incorporating existing scalp laceration and extending short of the helical root. (*D*) Exposure of the comminuted frontal bone fracture. Note the clinical absence of the frontal sinus. Reduction and resorbable fixation of the (*E*) frontal bone, (*F*) infraorbital rim, and (*G*) ZMC buttress. (*H*) Final postoperative result. As with porous polyethylene, resorbable fixation seems radiolucent.

redrilled and retapped through the remnant shank.[23] Newer technologies have been developed to avoid resorbable screws altogether. Some manufacturers have incorporated systems that use ultrasonic energy to melt pin-shaped polymers into predrilled osteotomies so that the material engages the bony channels and improves retention while at the same time avoiding the pitfalls associated with torqueing of screws. Resorbable screws cannot be used bicortically, and this is generally not a limitation in pediatric mandibular trauma where bicortical fixation is avoided.

The complication rates seem to be equivalent between resorbable and nonresorbable fixation; however, few studies have directly compared both materials head-to-head.[22,24] Moreover, resorbable fixation is widely accepted to be safe for use in children.[24] The complications associated with titanium implants are well described and include extrusion/exposure, infection, hardware fatigue, palpability,

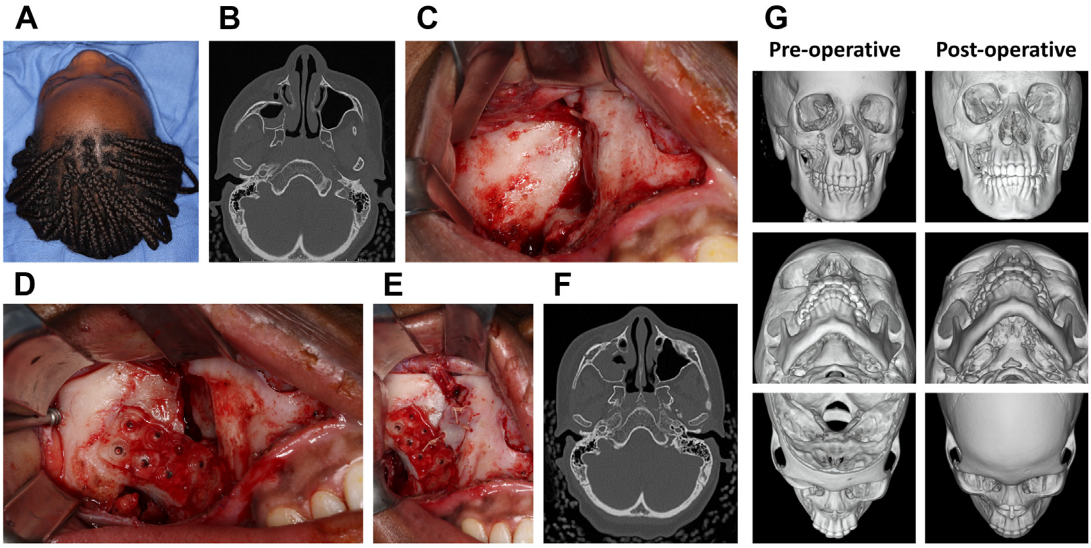

Fig. 16. Case of a right ZMC fracture in a 12-year-old patient. (*A*) Bird's eye view showing deprojection of the right malar eminence. (*B*) CT axial view verifying depressed ZMC fracture. The fracture (*C*) exposed through a transoral approach, (*D*) reduced with a Carroll-Girard T-bar screw, and fixated with resorbable plating. (*E*) Unsupported anterior maxillary bone fragment replaced and secured with bone sutures. (*F*) CT axial view of final postoperative result showing restored malar projection. (*G*) Comparison of preoperative and postoperative 3-dimensional renderings on frontal, worm's-eye view, and bird's-eye view.

and temperature sensitivity. Wound complications and hardware failure are also possible with resorbable implants; however, their transient nature may reduce the incidence of late complications. Many providers will account for the weaker mechanical properties of resorbable fixation during their treatment planning and elect to place patients into a short period of MMF.[23] This thoughtfulness probably accounts for the lack of difference in hardware-related failures when resorbable plates are used in the mandible.[22] A delayed foreign body reaction to microscopic PGA/PLA remnants can occur with bioresorbable fixation up to 2 years postoperatively.[24,25] This complication is seen in less than 5% of patients and typically presents as a palpable, fixed mass in the area of prior fixation. Larger volume implants are thought to be at higher risk for incomplete degradation, and these undigested remnants elicit a granulomatous inflammatory response. Fortunately, the offending fragments are fibrous encapsulated and usually able to be removed with a simple secondary procedure.[25] Finally, there is no convincing long-term evidence supporting the use of resorbable fixation for preserving growth potential. Provider preference and dogma dictate the choice of hardware because the decision is not currently limited by outcome data.

SUMMARY

Pediatric facial fractures are uncommon, and the majority is able to be managed with closed reduction or conservative therapy. Operating on the developing facial skeleton carries inherent risks of growth restriction and permanent injury to ossification centers and intrabony anatomy. Both resorbable (PGA/PLA) and nonresorbable (titanium) hardware are safe and appropriate in children. Resorbable implants are thought to reduce long-term complications but nonresorbable implants offer a more robust and rigid fixation. Most surgeons opt to retrieve nonresorbable hardware after 2 to 3 months of healing due to migration concerns. Growth restriction from internal fixation has multiple contributions. Properly placed hardware that respects natural suture lines is not thought to significantly inhibit growth. As materials science progresses, manufacturers can hopefully get closer to developing the ideal implant that combines the benefits of both fixation options.

CLINICS CARE POINTS

- Pediatric facial fractures do not often require internal fixation. Conservative management or closed reduction can be used for many situations.
- Internal fixation in children aged younger than 10 years is complicated by the presence of reduced bone stock and permanent tooth buds.

- Nonresorbable hardware has superior mechanical properties; however, there are concerns associated with implant size, implant strength, translocation, and, less so, growth restriction.
- Resorbable hardware obviates elective removal and is a reasonable alternative to traditional titanium implants in non–load-bearing regions.

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