Use of Resorbable Plates and Screws in Pediatric Facial Fractures

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Purpose: The use of resorbable plates and screws for fixation of pediatric facial fractures is both well tolerated and effective. It enables realignment and stable positioning of rapidly healing fracture segments while obviating any future issues secondary to long-term metal retention.

Patients and Methods: Forty-four pediatric facial fractures were treated over a 10-year period at our institution using differing techniques of polymeric bone fixation. Twenty-nine mandible fractures in patients under the age of 10 (age range, 6 months to 8 years) were treated. Displaced fractures of the symphysis, parasymphysis, body, and ramus underwent open reduction and either 1.5-mm or 2.0-mm plate and screw fixation in 14 patients. Subcondylar fractures were treated by a short period of maxillomandibular fixation (3 weeks) achieved with suture ligation between resorbable screws placed at the zygoma and symphysis or a circummandibular suture attached to a zygomatic screw. Fifteen patients (age range, 4 to 11 years) with isolated frontal, supraorbital, intraorbital, or orbitozygomatic fractures were treated by open reduction and internal fixation with 1.5-mm resorbable plates, mesh, and screws.

Results: No long-term implant-related complications were seen in any of the treated patients.

Conclusions: Resorbable polyactic and polyglycolic acid plates and screws can be an effective fixation method for facial fractures in children in the primary and secondary dentition periods.

Resorbable Fixation Devices

Although a variety of resorbable bone fixation devices of differing polymer compositions are currently available for craniomaxillofacial applications, this author has exclusively used co-polymer plates and screws composed of 82% polylactic and 18% polyglycolic acid (PLLA-PGA, LactoSorb; Walter Lorenz Surgical, Jacksonville, FL). Their long history of uncomplicated use in cranial vault surgery, favorable biomechanical properties, and a confirmed resorption time of 1 year or less make them ideal for the pediatric patient. The use of resorbable plates and screws involve 2 differences from similar-appearing metal de-

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vices. First, complex bending of the plates requires a heat source to allow the polymer chains to bend and not fracture. The mandible and forehead, however, have relatively flat and gently curved surfaces, which do not require enough bending to make this a concern. In the zygoma and orbit, more complex shaping of the plates may be needed. The placement of resorbable screws requires pretapping the screw threads before screw insertion, which is a 2-step process (ie, drilling and tapping).

Mandible Fractures

Pediatric mandible fractures are uncommon and have been treated by a wide variety of fixation methods. Incomplete or nondisplaced fractures as well as fractures of the subcondylar region are treated by traditional methods of a soft diet or closed reduction. Displaced fractures are better served by open reduction and internal fixation (ORIF).

Rigid metal fixation of mandibular fractures in children, however, can be complicated by a mixed dentition that can occupy the entire vertical dimension of the bone and places teeth and the inferior alveolar nerve at risk during screw insertion. In addition, ongoing development of the mandible poses risk of intrabony translocation of metal plates and screws, risking potential growth and teeth disturbances and difficulty with secondary removal if needed.

The goal of ORIF is a balance between stability of the fracture site and the potential risks of operative exposure of the bone. In children, this balance is particularly precarious as the implantation time of the metal devices is essentially for most of the patient’s lifetime. For these reasons, the use of resorbable fixation implants in developing facial bones is particularly appealing. Given the location of mixed dentition throughout the bone and the course of the inferior alveolar nerve, ORIF of the mandible in children uses smaller-gauge resorbable miniplates with...
monocortical screws. As the pediatric mandible is fairly malleable, fractures tend to be less displaced and rarely comminuted. Because the dentition is often mixed and more bone growth is expected, absolute compression of the fracture edges together is not necessary. These considerations, in conjunction with the difficulty in applying arch bars in the mixed dentition, allows for the use of a free hand technique during fracture repair.

Fractures are usually exposed through an intraoral approach unless an existing laceration allows for direct access to the bone through the skin. Once the fracture site is prepared, the bone edges are manually reduced while the dentition is held together in centric occlusion by an assistant. A 1.5-mm resorbable plate with at least 2 screw holes on each side of the fracture is held along the inferior border of the mandible in tooth-bearing regions. A short drill bit (1.1 mm in diameter, ≤5 mm in length) is used to place bone holes through the desired screw positions on the plate. The drill holes are through the outer cortex only so as to avoid drilling into unerupted teeth. A hand-held tap (1.5 mm) is then used to cut the screw threads. Resorbable screws (1.5 mm in diameter, 4 or 5 mm in length) are inserted until flush with the plate (Figs 1, 2). In most cases, 1.5-mm plates usually provide adequate fixation.

The free hand technique for maintaining a centric occlusion before plate fixation works fairly well for most isolated pediatric mandibular fractures. However, alignment of the visible buccal cortex does not always guarantee a perfect occlusal result, particularly in mandibular injuries with obliquely oriented fractures. In these fracture patterns, the lingual cortex may be misaligned and a gap on this side of the mandible may persist. Unlike fixation with more rigid metal plates, resorbable plates cannot really be overbent and their physical properties merely allow them to lie passively against the bone. Such lingual misalignment cannot be easily corrected by these less rigid resorbable plates. Because this classic principle of mandibular fixation cannot be effectively used, it is therefore important to carefully check occlusal interdigitation after resorbable plate placement.

When mandibular fracture alignment cannot be easily reduced or held properly in centric occlusion, an alternative technique is to place temporary wire ligation reduction across the fracture site (Fig 3). In this
technique, which may require a transcutaneous approach, metal screws are placed along the inferior border and a wire ligature is placed between them to reduce the fracture. While the reduction is held in this manner, a resorbable plate is then placed on the buccal cortex along the inferior border. The wire reduction devices are subsequently removed.

One significant advantage of resorbable screws in the pediatric mandible is the avoidance of potential odontogenic injury. As the drill hole and tapping of the screw threads penetrate only the outer cortex, injury to developing teeth is unlikely. Even if the resorbable screw tip encroaches upon a tooth, its tip is blunt and nonpenetrating. Subsequent resorption of the screw removes any potential obstruction to tooth eruption. As such, resorbable plates and screws may be applied in even the youngest mandible, where the entire bone is composed entirely of teeth and nerve (Fig 4).

MAXILLOMANDIBULAR FIXATION

A significant percentage of pediatric mandible fractures involve the condyle and can usually be treated with a short period of immobilization without surgical opening of the fracture site. In children, the frequent absence of teeth due to primary teeth exfoliation and the poor retentive shape of deciduous teeth crowns make the traditional use of arch bars and interdental ligatures impossible to apply. Several methods have been described for achieving mandibular immobilization in the child, including the use of acrylic splints and combined circummandibular and transnasal wiring. Acrylic splints, although effective, usually require intraoperative impressions and model fabrication, which are somewhat impractical given the value of intraoperative time and limited access to dental materials, expertise, and laboratory facilities. Transnasal wiring, combined with circummandibular wires, are also effective but risk injury to developing teeth along the pyriform aperture, the quality of the bone in the paranasal region or anterior nasal is thin, and wire engagement is not always secure. In addition, wire removal in children almost always requires some type of anesthetic for its removal.

In children, the amount of tolerance for displacement of the condyle is much higher than in adults and


method in endoscopic forehead surgery, a variation of a bone-anchored method as opposed to using the dentition may be used. This is accomplished through resorbable screws placed into the zygomatic body and mandibular symphysis to which is attached a large monofilament circummandibular suture. While it must be placed intraoperatively, this method of maxillomandibular fixation (MMF) is rapid and secure, does not damage the teeth, and can be removed in the office in the older child.

Under general anesthesia, a small maxillary vestibular incision is made bilaterally and the inferior aspect of the zygoma is exposed. A 2.0-mm resorbable soft tissue anchoring screw, in which a hole through the screw head had been placed during manufacture, is placed into the inferior aspect of the zygoma after an initial drill hole (1.5 mm) and 2.0-mm threads were created with a tap. One resorbable screw into each zygoma is all that is necessary (Fig 5A). An awl is then used to pass a large (0 or 2-0) nonresorbable monofilament suture around each side of the mandible through the small percutaneous stab created by the awl in the submandibular region. On the lingual side of the mandible, the suture can be passed either through the interdental space or around the last tooth in the arch so that both ends of the suture are in the buccal space. One end of the suture is finally passed through the screw in the zygoma and tied bilaterally with the mandible in centric relation (Figs 5B, C). The knot should be placed high in the maxillary vestibule so that it does not excessively irritate the gingival or buccal mucosa. An alternative technique that adds more interocclusal stability is to also place resorbable screws in the symphysis at the inferior border as well as that of the zygoma. The monofilament suture is tied between the 2 screws, thus avoiding the need for a circummandibular suture (Fig 6). When postoperative release is desired after several weeks, the sutures may be easily cut and removed in the office. The resorbable screws are left behind in the bone, which will be eventually cleared within the first postoperative year. In most children over age 5, the release may be performed in the office with no discomfort. In the younger child, sedation or a mask anesthetic may be needed due to their decreased level of cooperation.

This bone-anchored (zygomaticomandibular) form of MMF is particularly useful in children where the short roots and nontapering tooth forms limit their acceptance of any form of ligation. While wires may be stronger, the use of a large monofilament suture appears to be adequate (particularly when applied bilaterally) and may be more comfortable for the patient. The use of this MMF method in teenagers and adults has not been attempted and is suspect due to the higher forces generated by the masticatory muscles.
MIDFACE FRACTURES

Zygoma

Zygomatic bony injuries almost never occur in the developing face until the combination of globe development and pneumatization of the maxillary sinus is complete. Once this occurs, around the age of 7, the zygomatic prominence becomes evident and more likely to be traumatized and fractured. Due to the greater pliability of the bone at these young ages, most zygomatic fractures are incomplete with the frontozygomatic suture being the pivot point. As such, the zygoma is most displaced along the posterior maxillary buttress in most cases.

With this fracture pattern, intraoral reduction and single-plate application is usually the only fixation point needed. Realignment of the posterior maxillary buttress restores anatomic reduction along the infraorbital rim and lateral orbital wall.

Orbit

Fractures of the bony orbit are relatively uncommon in children but increase after age 7 due to the completed growth of the globe. Once a child is old enough so that pneumatization of the sinuses is complete, orbital fracture patterns resemble that of adults with floor blowouts being the most common fracture defect. Orbital roof fractures, which are rare in adults, may be seen in association with anterior cranial base injury from direct blunt trauma to the brow region.

Maxilla

Fractures of the maxilla (midface) are not likely to occur unless there is a maxillary sinus that provides an air space between the eyes and the teeth. When combined with the protective features of the juvenile face, such as a poorly projecting flat face and a greater amount of facial fat for padding, horizontal fractures in this region (Le Fort I) have not been seen by this author.
**Frontal/Brow**

Unlike adults, the prominence of the forehead and thinness of the bone in children makes fractures of the frontal bone, supraorbital rim, and orbital roof possible with direct impact-type injuries. With significant force, intracranial injury (pneumocephalus, epidural and subdural hematomas, and cerebral contusion) are seen. Posterior displacement of the frontal and supraorbital rim or inferior displacement of the orbital roof requires open surgical reduction. Wide exposure through coronal incisional access combined with a frontal craniotomy is often needed to dismantle the fracture sites, obliterate the involved sinus, and reassemble the contour of the brow and frontal bone. Fixation of the bone segments with resorbable 1.5-mm devices is well suited to the low load-bearing demands of this region (Fig 7).

Resorbable plates and screws can be an effective fixation method for facial fractures in children in the primary and mixed dentition periods. Whether used for plate fixation of fractures of the tooth-bearing region of the mandible, a bone-anchored method of MMF, or in the very low load-bearing upper and midface regions, they provide adequate stability for the rapid bone healing of youth. The blunt tips of the screws and their eventual resorption offer essentially no risk to developing teeth and nerve structures or ongoing facial growth and eliminates long-term foreign body retention. No delayed foreign-body reactions or inflammation has been seen with the resorbable polymers used in this patient series.

**References**