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Application of biodegradable plates for treating pediatric mandibular fractures



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ABSTRACT

Objective: We assessed the clinical results of a biodegradable plate system for the internal fixation of mandibular fractures in children, and observed the imaging features of fracture healing and bone changes around the biodegradable plates and screws during follow-up.

Patients and methods: We enrolled 39 patients (22 male, 17 female, average age 4 years 10 months) with different mandibular fractures. We used 2.0-mm resorbable plates to repair the fractures. Postoperative follow-up ranged from 6 months to 5 years; average follow-up was 1 year 2 months. The outcome measures identified and assessed included facial symmetry, mouth opening, occlusal relationship, infection, nonunion, malunion, and plate dehiscence.

Results: We fixed 42 fractures with 43 resorbable plates; the fracture site of one patient (aged 11 years 3 months) was fixed with two plates. Two patients developed small fistulas at the intraoral incision 2 months after surgery; the fistulas healed after 1 month without special treatment. In the other patients, the incision healed well, there was facial symmetry, mouth opening was >35 mm, and occlusion was good. Follow-up computed tomography examination data were available for 20 cases, and revealed different degrees of radiolucency indicating that osteolysis had occurred. Radiolucency was observed around the resorbable plates 1 month after the surgery. The extent and depth of the radiolucent region were obvious within 1 year of surgery. In the second year, there were obvious repairs, with the bony defect areas becoming shallower. After 2 years, the bony defect areas had almost disappeared.

Conclusion: Biodegradable fixation devices are safe and efficient for treating pediatric mandibular fractures. Osteolysis commonly follows biodegradable fixation of pediatric mandibular fractures, and has no adverse effect on fracture healing.

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1. Introduction

Mandibular fracture is one of the most common types of pediatric maxillofacial trauma (Grunwaldt et al., 2011; Iatrou et al., 2010). As the mandible in children is relatively soft and has good elasticity, incomplete fractures are more common; as there are permanent tooth buds in the mandible, the treatment of mandibular fractures in children is often conservative (Rottgers et al., 2011; Zimmermann et al., 2006). Given the progress made in bone-repair materials and the improvement of bone-repair technology, the proportion of children with mandibular fractures treated with open

reduction and internal fixation (ORIF) has increased. Currently, titanium plates and screws are the standard for craniomaxillofacial rigid internal fixation, but these are subject to disadvantages such as palpability, visibility, temperature sensitivity, interference with radiographic imaging, and excessive stress shielding. Furthermore, metal fixation may limit mandibular growth in children, and has to be removed in a second operation (Iatrou et al., 2010). Biodegradable fixation does not require removal and will be absorbed gradually – considerable advantages in the management of mandibular fractures in children.

However, there are some disadvantages to biodegradable fixation. First, the duration of the operation is longer as the plate bending requires a heat source, and resorbable screw placement requires screw-thread pretapping before screw insertion (Bell and Kindsfater, 2006). Second, due to insufficient strength of the fixed material, the plates may break and displacement and nonunion might occur after surgery (Vazquez-Morales et al., 2013). Third,

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foreign body reaction and complications may occur during the biodegradation and absorption of the plate and screws (Agarwal et al., 2009; Kallela et al., 1999; Landes et al., 2006; Turvey et al., 2011). In this paper, we summarize and analyze the results of biodegradable fixation of pediatric mandibular fractures, and observe the imaging findings for fracture repair and bone changes around the biodegradable plates and screws during follow-up.

2. Material and methods

Data were collected from 39 patients who underwent ORIF with biodegradable plates at our department from September 2008 to December 2013. There were 22 male patients and 17 female patients. The mean age was 4 years 10 months (range: 7 months to 12 years 9 months). Twelve patients were aged 0–3 years (30.8%), 19 were aged 3–7 years (48.7%), seven were aged 7–12 years (17.9%), and one was >12 years old (12 years 9 months, 2.6%). The causes of fracture were injuries from falls (26 cases), of which 10 were from high falls; and traffic accident injuries (13 cases).

Among the cases, there were 10 cases of 1-site fracture, 15 cases of 2-site fractures, 13 cases of 3-site fractures, one case of a 4-site fracture, and 83 fracture sites in total. There were 19 cases of symphysis fracture (19 sites), 14 cases of parasymphysis fracture (15 sites), six cases of corpus fracture (six sites), three cases of angle fracture (four sites), and 26 cases of condylar fracture (39 sites). Among the condylar fracture cases, there were 13 cases of unilateral fracture, 13 cases of bilateral fracture, 18 cases of intracapsular fracture (27 sites), and nine cases of neck fracture (12 sites).

All fractures were fixed using a biodegradable plate fixation system of 85:15 poly(L-lactide-co-glycolide) (PLGA, PolyMax; Synthes, Oberdorf, Switzerland). The plates are available in the form of 4-hole plates (1.0-mm thick). The screws for the system (2.0-mm diameter) are 4–10-mm long. The exclusion criteria were delayed and malunion fracture, bone defect fracture, infected fracture, and comminuted fracture.

2.1. Surgical methods

All fractures were treated through intraoral mucosal incision and the fracture lines were exposed adequately. Steel wires were used to ligate 4–6 teeth on both sides of the fracture line loosely initially. The fracture was reduced, the pre-injury occlusal relationship reestablished, and then the wires were ligated tightly (Fig. 1). An assistant maintained a good occlusal relationship, and intraoperative maxillomandibular fixation (MMF) was not required. A 4-hole resorbable plate was held along the inferior border of the mandible and adapted to the bone surface, with 2 screw holes on each side of the fracture. The screw holes were

drilled and the screws inserted after tapping with a hand-held tap to cut the screw threads (Fig. 2).

2.2. Treatment of condylar fractures

All condylar fractures were treated conservatively. Soft occlusal splints were fabricated for patients aged >3 years. The patients wore the splints after surgery throughout the day for 1–3 months (Fig. 3). In the first month after surgery, the patients were required to follow a soft diet and to perform mouth opening exercises 2 weeks after surgery.

Patients were followed at 1, 3, and 6 months, and 1 year after surgery. The ligating wires were removed 1 month after surgery. Clinical examination was performed to assess wound healing, facial symmetry, mouth opening, occlusal stability, infection, nonunion, malunion, and plate dehiscence. Fracture healing was assessed using radiographic examination.

3. Results

We fixed 42 fractures with 43 resorbable plates. We used 19 plates for 19 symphysis fractures; 16 plates for 15 parasymphysis fractures, two plates were used to fix the fracture site in one patient (aged 11 years 3 months); six plates for six body fractures; and two plates for two angle fractures.

3.1. Clinical follow-up

At 1 week after surgery, the wounds of all patients had healed well and there were no postoperative complications. Postoperative follow-up ranged from 6 months to 5 years; average follow-up was 1 year 2 months. In two cases of left parasymphysis fracture combined with right condylar fracture, small fistulas developed at the intraoral incision 2 months after surgery; the fistulas healed after 1 month without special treatment. The incisions of the other patients healed well, there was facial symmetry, a good occlusal relationship, and mouth opening was >35 mm. There was no temporomandibular joint ankylosis, nonunion, or osteomyelitis.

3.2. Imaging findings

Twenty cases underwent one or more computed tomography (CT) examinations during the entire follow-up period, which showed that the fracture lines healed normally. We observed radiolucency around the resorbable plates on the CT scans of all these 20 patients as early as 1 month after surgery, indicating that osteolysis had occurred. The extent and depth of the region was obvious within 1 year after surgery, and the bone underlying the

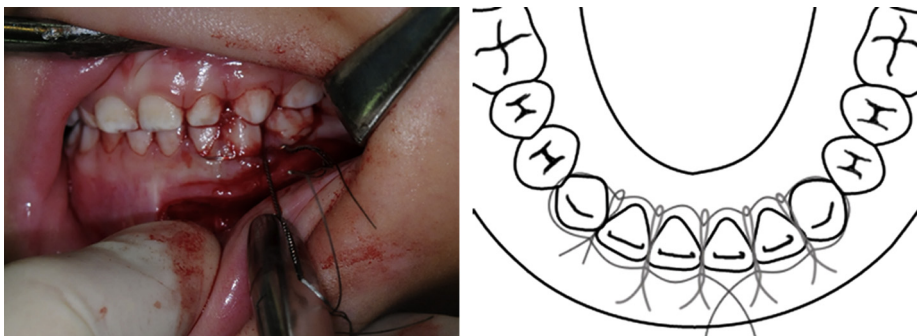


Fig. 1. Steel wires were used to ligate 4–6 teeth on both sides of the fracture line loosely initially. The fracture was first mobilized and the pre-injury occlusal relationship reestablished, then the fracture was reduced and the wires ligated tightly.

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