Evaluation of Biodegradable Fixation Application for Jaw Fracture in Pediatric Patients: A Case Report

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ABSTRACT

Background: *The treatment of jaw fractures in pediatric patients need a special concern and different management than adult patients due to their dynamic and structural changes following their growth patterns. Treatment by open reduction and internal fixation (ORIF) using titanium or biodegradable plates as osteosynthesis material is indicated for displaced jaw fracture. Biodegradable fixation could be used as an alternative choice, using plates and screw that will decompose along with bone healing.*

Case: *Two pediatric patients brought to RSUP Dr. Sardjito, Yogyakarta with complaints of jawbone fracture. The first patient was a 7-years-old woman diagnosed with mandibular symphysis fracture and a left mandibular kondilus fracture, while the second patient was a 15-years-old woman diagnosed with malunion of left maxillary fracture. Fracture treatment was performed using biodegradable fixation. The first patient was repositioned according to the anatomical state and the second patient the maxillary refracture was done before repositioning. Patients were evaluated clinically for up to three months postoperatively and radiological imaging was performed. Evaluation results show good jaw bone union, no malocclusion, no tooth mobility and no paresthesia in both patients. Intraoral wound dehiscence with exposed plate was found in the second patient at the vestibule of the left uper canine until premolar region and can be resolved by removal of the plates under local anesthesia*

Conclusions:*. Biodegradable as an ideal osteosynthesis material for jaw fracture in pediatric patients*

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INTRODUCTION

Management of jaw fracture in pediatric patients is different with adult patients. The management techniques should be modified to address the child's particular stage of anatomic, physiologic, or psychologic development.[1] Progression of bone repair materials (osteosynthesis) and technological developments make fracture management in children not only conservative but also begin to use open reduction methods in accordance with their indications. The titanium plate is standard in maxillofacial internal fixation, but however carries several potential problems such as allergies, stress shielding, corrosion, plate shifting, limiting bone growth in children and requiring future operation to remove the plate.[2]

Biodegradable fixation is an alternative choice of osteosynthesis as compared to the use of titanium plates. First-generation biodegradable materials began in the early 1970s with simple homopolymer compositions comprising of polyglycolic acid (PGA) and poly (L-lactic acid) (PLLA). The second generation of biodegradable materials has a composition almost similar to that of the first generation but has an additional lactic-co-glycolic acid (PLGA) additive which delivers longer degradation time and posseses better mechanical strength.

The biodegradable material as an ideal osteosynthesis material should be eligible to provide adequate mechanical strength from the first day of implantation and at the same time be degraded concomitantly with the time of bone healing.[3] These requirements are achieved by third generation biodegradable materials with the material composition of: L-lactide which provides strength for the material, D, L-lactide (DLPLA) which provides flexibility, polyglycolic acid (PGA) to affect resorption rate and Trimethylenecarbonate (TMC) acts as material flexibility and hardness.

CASE REPORT

Two pediatric patients came to Dr. Sardjito Hospital with suspected jaw fractures caused by an accident. The first patient was a 7-year-old girl with a diagnosis of a mandibular symphysis fracture and a sinister condyle fracture, while the second patient was a 15-year-old girl with a diagnosis of a malunion fracture of the sinister maxillary (figure 1a). Both were treated with fracture correction with an open reduction method which is indicated as treatment for displaced fractures. Biodegradable fixation is the choice of treatment, considering that the age of the patient is still within the age range of growth.

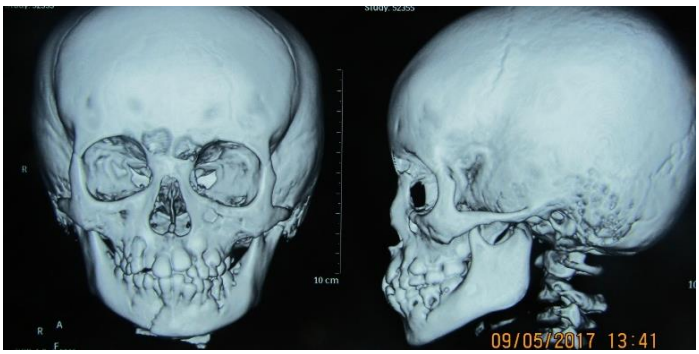

Figure 1a. Clinical photo and CT scan of the first patient

The first patient came into the emergency unit of Dr. Sardjito Hospital, Yogyakarta was referred from another hospital with a complaint of having mobility of anterior teeth and the inability to open her mouth wide. The patient was involved in an accident and had undergone wound stitching. Clinical examination of the patient showed limited ability of mouth opening (about 1 cm), facial asymmetry with swelling at anterior area of the mandible, there were stitches on the chin from treatment from the previous hospital. The intraoral state of the patient showed jawbone movement of regions 32 and 31, with mobility of teeth 32, 31 and 41 and lingual swelling of the stated area. Radiographic images of the head showed a mandibular symphysis fracture. Patient then underwent a CT scan examination of the head which showed cerebral edema with mandibular symphysis and sinister mandibular condyle fracture. The patient was treated at the neurological department and ORIF was performed ten days after the accident.

ORIF with the application of biodegradable fixation using four pieces of biodegradable extended long (4 hole) plates and biodegradable screw (2.5x8 mm) which were mounted across the fracture line at mandibular symphysis area. Adjustment of the shape of the plate with the mandibular anatomical shape was performed during surgery using warm aquabides with a temperature of 55°C. fracture of sinister mandibular condyle was treated with conservative treatment with considerations of high and non-displaced condyle fracture and the condition of the patient who is still in the period of growth. Repairment of the fractured condyle which will adjust and adapt to the patient's occlusion contact which has been corrected with biodegradable fixation.

Figure 1b. ClinicaliIntraoral and ekstraoral 1 month postoperation of first patient

Intermaxillary fixation was done 2 days post operation before the patient went home. Patient was evaluated for weekly controls and at the 3th week intermaxillary fixation was removed.

Evaluation was constantly performed on mobility anterior teeth, until the four week post-operation when interdental wire fixation was removed and occlusal grinding was performed adaptation of the anterior dental occlusion of the patient (figure 1b). Three months post-operation, patient was re-evaluated, no specific complaints from patient and OPG was performed for evaluation of mandibular bone healing. Evaluation results show good jaw bone union, no malocclusion, no wobbliness of teeth, no dehiscence wound and no complaints of paraesthesia (figure 1c).

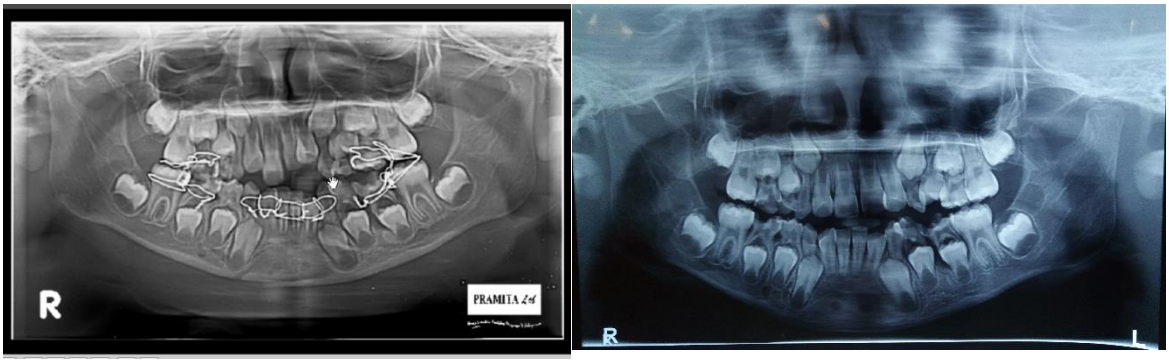

Figure 1c. OPG of first patient 1 month and 3 months post operation

The second patients came to the Oral and Maxillofacial Surgery department, complains that the upper and lower anterior teeth do not come in contact despite maximum closure of the mouth (figure 2a). The patient had previously been diagnosed with maxillary fracture from a road accident and had it corrected with ORIF using titanium plates. Clinical examination showed an openbite up to 7 mm. Patient was diagnosed with a malunion maxilla fracture post ORIF and is planned to be corrected by biodegradable fixation.

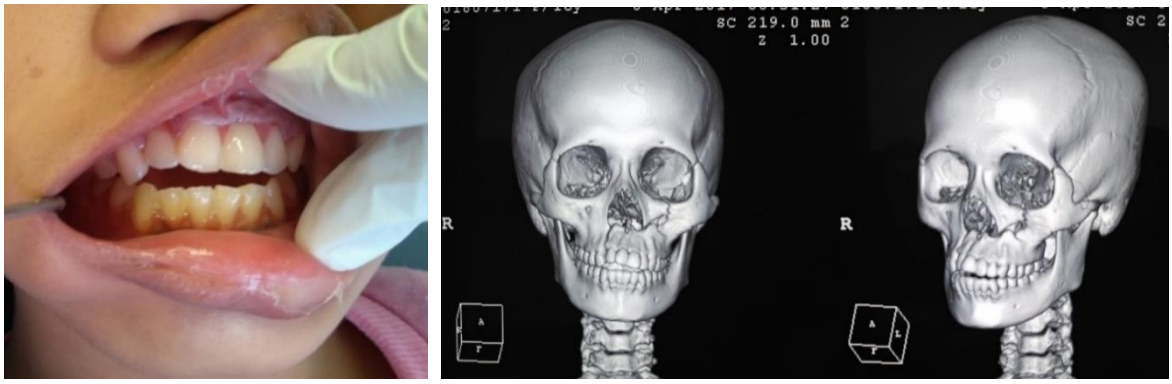

Figure 2a. clinical photo and CT scan of the second patient

The application of biodegradable fixation is done after refracturing to obtain an ideal occlusion. Plate fixation was done using biodegradable letter L (7 holes) on dexter and sinister maxilla with screw size 2.0x5 mm. The installation of elastic traction was performed 1 day post operation and jaw fixation with intermaxilary wire was performed on patient 2 days post operation before patient was sent home.

The patient is evaluated weekly. At the 3th week, intermaxilary wire was removed. The release

of the arch bar is done gradually at the 4th week for the lower jaw and the 5th week for the upper jaw. 12 weeks post operation, radiological imaging was carried out (figure 2b). Patient had no complaints of pain, parasthesia and no complaint of tooth mobility. Patient felt satisfied with the condition of the anterior teeth that can now achieve good contact, however clinical examinations show the presence of a dehiscence wound on the intraoral sinister maxillary area and 2 cm exposed plate. Patient was instructed to maintain good oral hygiene with a toothbrush and a 0.2% chlourhexidine gluconate mouthwash and return to control every week. The control results show that screw and plate begin to degrade every week.

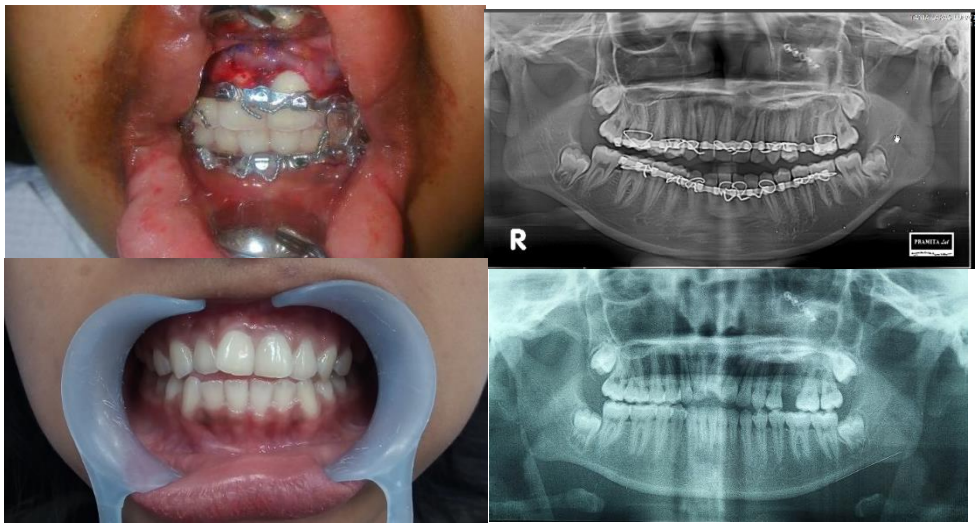

Figure 2b. clinical picture and OPG 1 month and 3 months post operation of second patient

In the 16th week of postoperative control, wound dehiscence showed signs of granulation under the exposed plate. The removal of unintact plates and biodegradable screw was done under local anesthesia and followed by dehiscence wound resuturing. During control in the 17th week, the stitching was removed. Evaluation results show the wound dehiscence sealed up well with no signs of inflammation.

DISCUSSION

The standard treatment performed for displaced fractures in children is by ORIF. Osteosynthesis commonly used in ORIF (titanium plate) carries several problems such as allergies, stress shielding, corrosion, limitation of bone growth and migration of plates and it requires extra effort of removing the titanium plates.[2] Biodegradable fixation has a smaller tensile strength when compared to titanium, but it still provides sufficient stability for fracture fragments.[4] The materials used for plates and biodegradable screw are always renewed by various invitro tests, experiment on animals and also clinical trials. The biodegradable fixation applications on both patients in this case report use the latest materials that have a degradation time which synchronise with bone healing time (figure 3a).

Figure 3a. Plate and biodegradable screw

The first patient who needs to be managed with some treatment modifications suitable for patients who tend to be uncooperative. The mobility maxillary anterior tooth of the patient require adequate fixation to restore the function of the tooth. The fixation of an arch bar for tooth repositioning cannot be performed because the patient is still in her mixed dentition period with teeth with relatively shorter crowns.[2] Stability can be achieved by using interdental wire instead of arch bars.[5]

Correction of mandibular symphysis fractures in this case is done by an open reduction method due to the type of displaced fracture and the need for correction to obtain primary healing of the bone (contact healing). Wakins et al (2014) provides a reference that management of mandibular fractures at ages 8 to 16 years are by ORIF, using miniplate / microplate / biodegradable plates. The ideal stability and ideal occlusion can allow bone healing (contact healing) in pediatric patients to be faster than in adult patients. According to Sheikh et al (2015) the plate and biodegradable screw will gradually lose the retention strength after six weeks and will be completely degraded within two years (figure 3b). ORIF treatment requires stability of bone fragments to pass through a healing phase that lasts for two to three weeks post trauma.[6] The retention force that lasts for six weeks on biodegradable materials enables optimal bone healing processes to occur before the degradation of plate. Combined with intermaxilary fixation for 1 to 4 weeks should still be performed in cases of jaw fracture with biodegradable fixation, to obtain optimal stabilization.[2]

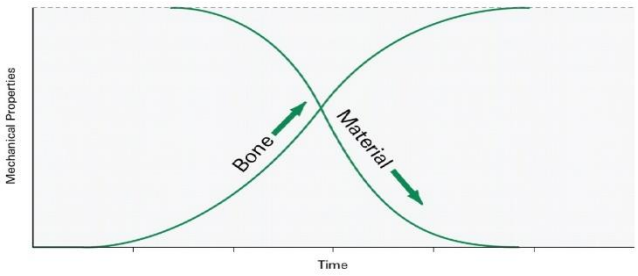

Figure 3b. comparison of degradation time of biodegradable materials to bone healing

The screw with a short size (8mm) and placement of the palate along the lower margin of the mandible which would effectively avoid injuring the permanent tooth germs.[2] The impact of ORIF on the growth of facial bone remains an unsolved problem. Another study of craniofacial anatomy after application of plates in animal bone shows results that are still in debate.[5] The pattern of bone growth on the mandible that has been corrected with titanium plates shows that some cortical bone structures will cover titanium plate if not removed within a certain period of time.[7] Titanium plate

removal in pediatric patients aged less than 16 years is recommende to be performed before the third month of postoperation.[7] The use of biodegradable fixation can at least take away the need of removing which is suspected to affect bone growth patterns. The bone growth in the patient may continue without any retention barriers and no allergic reactions from the plates.

The use of biodegradable fixation should still follow two main principles of pediatric patient's jaw fracture, short duration of fixation with early mobilization and routine exercise.[8] Biodegradable fixation may result in earlier recovery of mandibular function according to the concept of open reduction method that provides contact healing. Proper fixation and exercise of joint function at baseline postoperatively may prevent the occurrence of condyles joint ankylosis in pediatric patients with mandibular fracture.[2] In contrast to the mandibular sympysis fracture performed by ORIF, the mandibular condylus fracture in the first patient was performed by a closed method. Non-displaced fracture condyles in pediatric patients are indicative of closed reduction.[6,7] Occlusion can be achieved after fracture correction of the mandibular sympisis. The recovery of the mandibular condylus function in the first patient can be seen from the control results at 3 months postoperatively, the patient can open the mouth up to 3.5 cm maximum, no pain complaints and no deviation when opening and closing the mouth. Radiograph evaluation shows a good bone union on the sympisis mandibula and the mandibular mandibular condyles.

The second patient with a diagnosis malunion post ORIF. Malunion is a condition of bone fracture that heals in an unsatisfactory position and causes deformity.[9] Malunion occurs due to inadequate bone fragment stabilization, missalignment at the time of repositioning, or the premature removal of fixation device. Stabilization of bone fragments is a primary requirement for primary fracture healing.[10] The use of stable osteosynthesis materials will result in a healing fracture known as contact healing. Mesenchymal cells from the haversian canal of the contact healing will differentiate into osteoblasts and osteoclasts, then the formation of osteon and lamellar bone. [11] Bone fragment resorption does not occur because osteoblasts and osteoclasts run parallel.[12] Contact healing is only possible if there is a very good adaptation between fragments.[13]

Figure 3c. removal of exposed plate 3 months post operation

Correction of malunion is performed by primary callus removing which has been formed after the first surgery. Occlusion repair is performed in the anterior region by repositioning maxillary anterior teeth as close as possible to the mandibular anterior teeth. The use of arch bar can be done because the patient is in permanent dentition period. The use of biodegradable fixation and intermaxillary fixation provides good post stabilization correction of maxillary fracture

malunion. The release of the arch bar is done gradually to evaluate the occlusion of the patient.

Intraoral wound dehiscence that occurs in patients at 12 weeks postoperation is known from clinical examination. The wound occurs in the incision wound in the sinister maxillary vestibule area. Patient did not complain of pain, bleeding nor swelling around the wound area. The exposed biodegradable plate appears to be degrading from the screw portion. Intraoral wound dehiscence can occur due to several factors.[14] According to Booth et al (2007) intraoral wound dehiscence may occur due to the lack of incision in the attached gingiva area. Insufficient mucosal tears and poor oral hygiene are factors that play a role in the occurrence of dehiscence.[15] Removal of plate is still done to prevent the occurrence of infection that can impede the wound healing process. One week after suturing, the removal of the stitches is done. Evaluation results show wound healing can occur well.

CONCLUSION

Biodegradable as an ideal osteosynthesis material for jaw fracture in pediatric patients. Biodegradable fixation has the advantage of having degradable plate and screw so that no further operation is required for plate removal. The removal of biodegradable plates still has to be done if there are complications such as exposed plates with post operation wound dehiscence.

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