CHAPTER 4

DISCUSSION

The development and widespread application of internal metallic bone fixation over the past 20 years has been one of the most significant advances in craniomaxillofacial surgery since the basic concepts of secure bone fixation and primary bone healing were introduced several decades previously. With the extensive use of fixation technology in craniofacial surgery in particular, it is now apparent that there are several potential postoperative complications that may occur. Some patients will require device removal in their lifetime as a result of skin irritation, infection or exposure of the underlying plates and screws. These potential risks with metal fixation make the use of resorbable polymer fixation devices a logical choice. The ability to achieve good intraoperative bone stability while allowing postoperative device resorption would eliminate all potential future devicerelated complications. The primary author has previously reported on an initial series of patients who received resorbable poly-L-lactic-polyglycolic (PLLA-PGA) plates and screws.

Biocompatible and resorbable poly-(alphahydroxy) acids like poly-L-lactide (PLLA), polyglycolide (PGA) and polydioxanone (PDS) have frequently been proposed as potential materials[90]. Reed and Gilding[91] have shown in their study that the glycolic acid/lactic acid family of mono- and copolymers has a wide range of degradation rates that are governed by both the hydrophobic/ hydrophilic balance and crystallinity. The degradation mechanism is simply hydrolysis, which is insensitive to pH for most compositions. Polymeric materials such as PLLA and PGA have advantages and disadvantages and this has led to the idea of the use of copolymers. Recently, the use of a copolymer of PLLA and PGA has had wide use in numerous operations. An initial use of this material was in paediatric craniofacial surgery where less rigid strength of fixation was required. [92]

Subsequent applications have been extended to the repair of midfacial fractures and maxillary and mandibular osteotomies.[93] Depending on size and location, these materials are absorbed in 9–15 months.[94] But the disadvantage of resorbable plate & screws are more expensive than titanium plate&screw, more complicated fixation , increase operation time.

Rigid fixation using miniplates is described as a system composed of a plate attached to the bone by screws through the bone-screw interface. Therefore, the biomechanical functions of rigid fixation systems clinically depend on the interaction between all three components, which are plate, screws, and bone. A bone-plate-screw system requires precise adaptation of the plate to the underlying bone. Without such intimate contact, the tightening of the screws draw the bone segment towards the plate and result in alterations in the position of the segments and the occlusal relationship .

In the laboratory testing, the suitable of mandible must be selected for the bilateral sagittal split ramus osteotomies. Many studies were used many kinds of the species of the mandible such as the mandible of porcine, sheep, rabbit that in this study, we used the porcine mandible because its cost, size,shape, structure and easily to manage which are similar to the human of mandible.

The titanium plate 4 holes and the self tapping screws were used and the resorbable plate 4 holes and the non-self tapping screws were used in this study are the copolymer of PLLA/PGA that were made for the mandible.The resorbable plate have the elasticity that would make slightly bending possible and the preparation of the resorbable plate were heated in hot water bath at 57^{o} C to improve malleability that the material can bendable to the contour of the facial bone.

The biomechanical testing was used by the universal testing machine that the specimens must have the custom made cradle for holding the specimens in the same position that were adjusted. The custom made cradle in this study was designed special for this study. It made of stainless steel and have the lock to hold the parts of mandible when were applied the vertical loading.This model is the 3 point model that was used in many studies.

In this study, the universal testing machine was used because it can control the direction and force, can selelect and apply force in same place and position and can get the biomechanical data completely from the software presents in the tables and graphs that easily to analyze this results. The vertical loading is easily to manage and control, reproducible, discriminating in all testings. Vertical loading is the relationship between load and displacement in one plane. In this study, the vertical loading that was start at 0 N to the failure point on the same position in same distance for each experimental groups that can respect the result of the study. However, the actual situation produce much more stress-strain relationships in even the

simplest three dimensional representations of a mandible.[86]

The in vitro study have many advantages that can reduce the other factors have an affect on the results, can control the same environment of all specimens in all tesing. This study can use the fresh porcine mandible for keeping the elasticity of bone that cannot deal with the fresh humen mandible. In addition to the in vitro study are the inexpensive, discriminating, reproductible testing. So the in vitro study is suitable for this study. But its limitation that are the model is 2 dimensional can not representation the complex 3- dimensional clinical environment, using a force applied vertically whereas vertical, lateral and rotational force in clinical environment. Actually, plate is affected by physiologic environment. A single continuous load application until failure, not cyclically loaded as in normal function.

The porcine mandible were selected and cut in midline for left and right hemimandible. The left side were performed in bilateral sagittal split osteotomies and fixed by titanium plate and screws and the right side of same mandible were performed in bilateral sagittal split osteotomies and fixed by resorbable plate and screws. The same group was separated to 3 subgroups are 0 mm, 5mm, 10 mm that can compare the result of each group.

Three factors can potentially influence resistance to rotation at the osteotomy site in a sagittal split osteotomy. The first is the friction created when one split surface slides across another during rotational deformation. Most surgeons smooth bony irregularities along the split surfaces of the mandible to decrease the potential for nerve injury and maximize bony contact along the osteotomy; the authors did this in the present study. Removal of bony irregularities plus fixation with position screws, without interfrag-mentary compression, should minimize the effects of friction in this study. The second effect potentially influencing resistance to rotation is bony buttressing present along the osteotomy in the buccal cortex if the segments are returned to their preoperative position or if the buccal cortex is judiciously removed in a mandibluar setback. There is no buttressing effect in a mandibular advancement. The methods section in this study is not sufficiently clear to determine if the mandibles were "advanced" "setback" or simply fixed in their preoperative position. The third effect influencing resistance to rotation at the osteotomy site is provided by the fixation devices, in this case are bone, plate and screws. [87]The thickening of cortex of bone may affect the strength of plate and screw fixation so, this study used the similar age of the porcine mandible for the similar thickenimg cortex.

The biomechanical data of this study presented in the load-displacement curve

that the graph of the resorbable group is similar to the graph of titanium group.The load-displacement curve show the biomechanical data are the maximum load, deflection of maximum load, stiffness, load at rupture, deflection of rupture. The stiffness is the slope of the curve that show the strength of fixation found that the stiffness of the titanium group is similar to the stiffness of the resorbable group so, the strength of fixation of 2 kinds of plate and screw may similar. For the maximum load is an engineering standard that has been used in the evaluation of fixation system [66,67,68] . This value should indicate the maximum amount of force that could be resisted by the systems until the breaking point. The mean bite force[75] of patient who had undergone SSRO at 2 weeks PO is 66.5 N and at 4 weeks PO is 128.8 N. In clinical, the masseter and tempolaris muscle was found -that their post-op activity decreased and take up to full recovery in 3 months. In this study, the maximum load 130.33±12.82 N in Re gr. and resorbable plate and screw can tolerate peak load forces in the actual postoperative patient. The deflection at maximum load show the changing of displacement when the specimen was applied the maximum load. For this study found that deflection at maximum load is insignificant changed in the titanium and resorbable group. The load at rupture is the last force that the the fixation can tolerate. In this study found that the resorbable group is lower than the titanium group because some of the resorbable screw were broken that may decrease the strength of fixation. The deflection at rupture is the changing of displacement when the load at rupture was applied. In this study found that the deflection at rupture is insignificant change in the titanium and resorbable group. However, the biomechanical data found that the data of the titanium group is higher than the data of the resorbable group but no statistic difference at $p<0.05$.

In addition to this study have subgroups are the mandibular setback 0 mm, 5 mm, 10 mm in the titanium group and the resorbable group.The result in the 5 mm set back group is minor different from the 10 mm setback group found that the maximum load of the 10 mm set back group is more than the 5 mm setback group showed the biomechanical data of the mandibular setback is more than 5mm in the titanium group and resorbable group because the distance from the application point is shorter accord with other studies.

The result of the titanium group after vertical loading found that the screw of some specimens were slightly loosen from the started position that made the the bone segment displacement and found the bending of titanium plate but no the broken plate and screw that differed from the resorbable group. The result of the resorbable group after vertical loading found

some resorbable screw were broken but no broken plate.

The reasons of the broken resorbable screw were caused by many factors that affected the strength of fixation were examined and found that many factors have been implicated in governing the holding strength of bone screws, including external screw diameter, pilot hole size, presence of a channel in the screw, number of self-tapping threads, pitch of the screw, and cortical bone thickness. It has been well established that the holding power of bone screws increases with increasing cortical thickness. Complex mandibular anatomy and cortical bone thickness affect the strength of screw fixation techniques. In addition, it is difficult to duplicate the complexities of mandibular motion and loading in vitro.

Some screws were broken after applied loadng but no broken plate in the resorbable group may be cause by the stiffness of the resorbable screw is lower than the stiffness of bone and the position of screw is perpendicular with the vertical loading but in the titanium group no broken screw may be cause by the stiffness of titanium is similar to the stiffness of bone and may be caused by the resorbable screw is the non self tapping screw but the titanium screw is tapping screw that conformed to the study of R. Leggon[95] showed the strength of fixation of tapping screw and non-self tapping screw founded that in the thin cortex bone such as facial bone, the strength of fixation of the self tapping screw is more than of the non self-tapping screw.

In this study, the screw engagement were controlled before all specimens were apllied loading by the Perio-test at level 0-level I and after loading the screw engagement were recorded that found the screw engagement were deceased in all screws of all specimens.The reasons of this result may caused by bone microcracking around screw threads before and after loading was observed by scanning electron microscopy. More microcracks were observed after application of shear loading. The non-self-tapping screw might have loosened more than the self-tapping screw from this applied loading schedule.[96]

The result of the study have added to our understanding of some of the biomechanical properties associated with using plate-screw fixation in the sagittal split osteotomy and have provided a strong basis for continuing research in this area.

It should to be note that in this study a simple approximation of the complex physiological forces on the mandible was used and the test evaluated only on the initial fixation stability rather than cyclic stability.