

Evaluation of mandibular bone segments changes with early versus delayed functional loading after symphyseal fracture fixation using resorbable bone plates.

Atef Abd El Hameed Fouda

Oral & Maxillofacial Dept.-Faculty of Oral and Dental Medicine, Cairo University , Cairo , Egypt.
Corresponding Author E-mail: atef_fouda@yahoo.com

Abstract: Background: Improper fixation during fracture healing leads to malocclusion. Mandibular bone segments and subsequently occlusal changes that may result after mandibular trauma treatment interfere with establishment of stable occlusion in so-called adapted centric posture. The aim of the present study was to evaluate these changes during and after symphyseal fracture treatment with early versus delayed functional loading. **Methods:** Twenty four fully-dentate adult male patients with mandibular symphyseal fracture were divided into two equal groups. In the first group two poly lactic acid plates were used for fracture fixation, while the other group treated the same as first group and MMF were performed for one week postoperatively. To evaluate bone segments displacement the patients were subjected to antero-posterior cephalogram for measurement of inter-gonial distance. **Results:** significant bony segments displacement reported in group I patients. **Conclusion:** MMF recommended to be applied for one week after use of poly lactic acid (PLA) plates in symphyseal fractures fixation. [Atef Abd El Hameed Fouda. **Evaluation of mandibular bone segments changes with early versus delayed functional loading after symphyseal fracture fixation using resorbable bone plates.** Journal of American Science 2012;8(1):1-6]. (ISSN: 1545-1003). <http://www.americanscience.org>. 1

Keywords: symphyseal fracture, malocclusion, resorbable plates, mandibular fracture.

1-Introduction:

Mandibular fractures belong to the most common fractures encountered in maxillofacial trauma. Because mandible is such a unique structure with hinge joint and masticatory muscles attached to its body, attention must be paid to avoid displacement during treatment. Displacement after fracture reduction leads to malocclusion and temporomandibular joint affection, Hylander and Johnson (1994); Hylander et al., (2000); Rosemary et al., (2007).

Symphyseal fracture is known to cause concomitant damage to the muscles of mastication. Pull of the masticatory muscles may lead to bony segments displacement that resulted in decrease of jaw opening, and dental malocclusion, Pullinger and Seligman (1991); kim and Nam (2001).

It is known that occlusal contact and muscle contraction set up twisting forces on the mandible, thus separating the fracture gap inferiorly. Mechanically, this deformation have been caused by a combination of jaw movement and occlusal force, with the latter being the dominant element, Turvey et al., (2011).

Open-reduction and rigid internal fixation with plating systems (ORIF) is now integral to the management of mandible fractures. Owing to its advantages; early return to function and better patient acceptance over conventional maxillomandibular fixation (MMF), ORIF is frequently used to treat

mandible fractures particularly in noncompliant patients, Zachariades et al.,(1996); Vivek et al.,(2008).

Bone plates and screws were manufactured from a variety of metals, including stainless steel, vitallium, chromium-cobalt, and other metal alloys. Recently more compatible titanium bone plates and screws developed for use in the cranio-maxillofacial region. The difficulty in removing the material with subsequent surgery, interference with imaging, generalized health safety, and concerns about bone healing and maturation encouraged the development of more biologically and physiologically compatible materials as poly lactic acid bone plates (PLA), Surronen et al.,(1998); Turvey et al.,(2002).

Fracture fixation osteosynthesis is a surgical technique that using appropriate mechanical tension-stress that stimulates and maintains osteogenesis. It is generally accepted that mechanical stress influences the course of fracture healing. A flexible fixation of the fractured site can induce fracture callus formation, whereas an unstable fixation can lead to a non-union, Yukata et al., (2009).

Surgical periosteum injury and masticatory loading are factors affecting the healing of a mandibular fracture site. The results suggest that periosteum injury inhibits early mandibular healing, whereas micro-movement from soft diet mastication mechanics has a negligible effect, Sun and, Herring (2009).

Rigid fixation allows the treatment without the use of maxillary mandibular fixation to avoid its disadvantages The required strength of plates and

screws differs depending on the functional demands of the bones to be stabilized. The functional demands of the craniofacial region (forehead, calvaria) are much less than the maxillofacial region (maxilla, mandible, orbits) where the heavy forces of mastication are applied and dispersed superiorly and inferiorly, Hoffman et al.,(1990); Fordyce et al.,(1999);

Champy et al (1978) reported that the major concerns for use in the maxillofacial region are the strength of the material and its ability to withstand masticatory forces. The ideal fixation system for stabilization of bone fracture would provide adequate strength initially to permit bone healing during function, Turvey et al.,(2011).

According to Meyer et al (1999) the strain of masticatory micro movement is certainly high strain which promotes fibrous tissue rather than bone formation. During chewing, lateral transverse bending occurs after the initial maximum intercuspation, which is associated with the activity of the masseter muscles coupled with the activity of the medial pterygoid muscles Hylander (1984).

Medial mandibular deformation characterized by a decrease in arch width because of contraction of the lateral pterygoid muscles, causing high strain in the symphyseal region, Brown et al.,(1989). The cyclic nature of masticatory micro movement was found to result in superior gap narrowing and inferior gap widening of the fracture line, Daegling and Hylander (1997); Liu and Herring (2000).

The muscle activity on the mandible is considerable where the supra-hyoid muscles activity was influential, and if patients are not cautious with chewing, problems can occur as masticatory force exceeds the strength of the fixation screws and/or their surrounding bone. In these circumstances bone resorption occurred around screws. Sometimes breakage of this material occurred within the first 3 weeks following surgery. Early detection requires careful clinical observation of; occlusion, mandibular symmetry, and patient symptoms, Turvey et al.,(2002);Turvey et al.,(2011) .

Mobility of the bony segments with the use of the poly-lactate systems is much more frequent than with the use of more rigid titanium systems which is too rigid and does not easily allow movement of the segments Turvey et al.,(2011)

In a study, Turvey et al.,(2002) included 745 patients undergoing a variety of cranio-maxillofacial procedures (>1400) over a 10-year period suggests that PLA plates have a definite place for many surgical applications. The failure rate of 6% is within the same range of experience as titanium when applied the same way. Although the failure rate has been surveyed less for titanium plates when used for

treatment of mandibular fracture patients, Zachariades et al.,(1996); Shetty et al.,(2003);Vivek et al.,(2008) .

Renton and, Wiesenfeld (1996) In their study reported that; cases treated with titanium plate fixation and mouth opened immediately after surgery approximately 17% to 19% of cases presented with a transient malocclusion , 4% to 8% of them required correction with an occlusal adjustment, and 0.5% to 3% required a secondary revision surgery. In clinical practice, in order to avoid segment displacement mastication of a soft diet is often encouraged early after the reduction and fixation surgery, Hylander and Crompton (1986) ; Liu and Herring (2000).

On the other hand, investigations, Goodship AE, Kenwright (1985); Kenwright and Goodship (1989);Kassis et al.,(1996) have suggested that physiological loading may play an important role in bone regeneration. Micro movement (<1 mm) across fracture segments stimulates the healing process in both animal and clinical studies, suggesting that well controlled early functional loading may actually help fracture healing, while excess mobility (≥ 2 mm) can inhibit healing .Evidence from long bone osteogenesis, application of 0.2 mm of micro movement for 15 minutes daily to a rabbit tibia actually enhances bone regeneration in the consolidation phase, Sun et al.,(2006).

The greatest benefit of using PLA plates is its ability to permit healing to occur and to allow gradual transference of physiological force to bone over time. The complete healing observed may be attributable to the enhanced tissue perfusion secondary to low-grade inflammation, which is necessary for biodegradation to occur. Minor mobility with the use of the poly-lactate systems in the fracture fixation is expected and is much more frequent than with the use of more rigid titanium systems, Turvey et al.,(2002).

Dawson (1995) stated that during the treatment of the mandibular fracture, dentists have to concern whether the occlusion of the patients has changed or not. When fractured segments of the mandible are reduced the three dimensional position of the mandible should be restored correcting the deformation caused by the trauma.

Champy et al (2000) Reported that The major concerns for use in the maxillofacial region are the strength of the material and its ability to withstand masticatory forces, Turvey et al.,(2011).The ideal fixation system for stabilisation of bone fracture would provide adequate strength initially to permit bone healing during function, Turvey et al.,(2011). The purpose of this study is to evaluate the efficacy of open-reduction and rigid internal fixation with PLA plating system with early functional loading regarding post traumatic bone segments changes and subsequent

occlusion after treatment of mandibular symphyseal fractures.

2. Materials and methods:

2.1. Methods:

2.1.1. Patients:

Twenty four patients who agreed placement of PLA bone plates and screws were selected according to the following criteria; free from any systemic diseases, suffering from recent non infected single line fractured symphyseal region, the inter-fragmentary displacement should not be less than 5 mm. and with complete dental arches.

Excluded from this study patients have other concomitant fractures of the jaws, and patients more than 90 Kg. in body weight.

Success was defined as evidence of healing in the desired position without the need for additional surgery. Failure is defined as material breakage or an acute inflammatory response during the biodegradation phase, to the extent that another operating room procedure was necessary for restabilisation or debridement.

Routine pre operative assessment with digital panoramic x-ray was performed for all patients.

Patients were divided into two groups:

Group I: Included twelve patients with symphyseal fracture treated by open reduction osteosynthesis using PLA plates and screws with functional loading immediately post operatively and patients were instructed to eat soft food.

Group II: Included twelve patients with symphyseal fracture treated by open reduction osteosynthesis using PLA plates and screws with MMF applied immediately post operatively for one week.

2.2. Methods:

2.2.1. Surgical procedure:

After proper anaesthetic investigations and profile assessment. Under general anaesthesia, MMF applied to all patients pre-operatively using Erich arch bars and heavy elastic traction. Trans-oral approach, was used for application of PLA plating system that met the criteria for use in the entire maxillofacial region (*Bionx, LTD, Con Med Linvotech, Key Largo, FL, USA, L/DL-lactic-acid 70/30*). Plate adaptation performed with heating in a warm saline bath, drilling, tapping, and screw insertion. Two plates used for fracture fixation, one large plate (six holes) at the stress line below the teeth apices by 6 mm, and the second short plate (two holes) fixed at the mid portion of teeth roots with the screws inserted cautiously between the roots of the teeth. Closure of the wound using three zero resorbable sutures.

For group I patients, removal of elastics and arch bars were done immediately post operative after cephalometric x-ray was performed, while patients of group II MMF left for one week.

2.2.2. Follow up:

Antero-posterior cephalometric x-ray was done while the patient bite in centric relation, at immediate, two weeks, and after six weeks post operative.

2.2.3. Measurements:

After cephalometric x-ray tracing and determination of gonial points bilaterally, Inter gonial distance was measured and recorded for each patient. The same procedure repeated at all follow up periods for both study groups. (Table 1,2). The Data collected were statistically analyzed using paired t-test. Significance level determined ($P \leq 0.05$).

Table (1): Inter gonial distance measurements in millimetres for group I patients

Pt No.	Immed.	Two weeks	Six weeks
1	112	113	113
2	106	106	107
3	108	110	110
4	106	109	110
5	115	117	117
6	114	114	114
7	94	96	96
8	104	108	108
9	105	107	107
10	112	112	113
11	99	101	101
12	107	107	107

Table (2): Inter gonial distance measurements in millimetres for group II patients

Pt No.	Immed.	Two weeks	Six weeks
1	98	99	99
2	108	108	108
3	114	114	114
4	106	106	106
5	99	99	99
6	106	106	107
7	116	117	117
8	107	107	107
9	105	105	105
10	99	99	99
11	112	112	112
12	107	107	107

3. Results:

The difference between both test groups regarding the immediate post operative measurements not significant.

For group I patients there is significant difference between immediate post operative measurements and measurements after two weeks and six weeks respectively, while there is no significant difference between measurements of two weeks and six weeks. (Table 3)

For group II patients there is no any significant difference between immediate post-operative measurements and measurements after two and six weeks post operatively. Furthermore there is no significant difference between two weeks measurements and six weeks measurements (Table 3).

Table (3): Comparison of changes in inter-gonial distance between Group I VS. Group II along follow up periods

	Immediate Post-op	Two weeks Post-op	Six weeks Post-op
Group I			
Mean	106.83	108.33	108.58
SD	6.11	5.72	5.77
P value	-	0.0022*	0.0006*
Group II			
Mean	106.41	106.58	106.66
SD	5.77	5.80	5.80
P value	-	1.22	1.04

Paired "t" test

*Significant ($P \leq 0.05$)

4. Discussion:

This clinical study based on that open reduction of fractured mandible sometimes resulted in changed occlusion, and the need to establish stable occlusion in so-called adapted centric posture, demonstrated the importance of occlusal consideration when maxillofacial surgeons treat mandibular fractures with less rigid plates.

Changes in the Inter-gonial distance may be an indicator for mandibular bone and subsequently occlusal changes that may happen after mandibular symphyseal fracture treatment, which is the main concern for both the patient and the surgeon.

The aim of the present study was to evaluate these changes that may be resulted during and/or after symphyseal fracture treatment using poly-glycolic acid bone plates with early versus delayed functional loading in order to establish proper occlusion without centric posture changes.

The results explains that early loading after symphyseal fracture treatment with resorbable PLA plates resulted in significant increase in the inter-gonial distance and subsequently changes in centric dental relation at three and six weeks post-operatively.

The increase in the inter-gonial distance resulted from that masticatory mechanics of the mandible has great effect on osteogenesis site. The Lateral forces produces primary compressive stress and strain on the labial aspect, and primary tensile stress and strain on the lingual aspect of the symphysis, a third loading pattern which occurs during jaw opening and has been postulated to be caused mainly by the bilateral contraction of the lateral pterygoid muscles, producing a reversed lateral displacement effect, Hylander (1984); Hylander (1985).

Fixation plates at the symphysis enables all working- and balancing-side jaw adductor muscles to increase occlusal forces during unilateral chewing. Fixation strength help in reducing the risk of healing failure, or improper segment alignment, as a result of lateral transverse bending forces resulted during unilateral mastication.

In the current study two PLA plates were used for fixation of para-symphyseal fracture seeking more stable fracture segments; because this region is not only exposed to compressive forces but also tension and torsion forces according to previous studies, Hylander et al.,(2000); Feller et al.,(2002).

To decrease the possibility of segment displacement during the stage of reduction Pre-tapping for screws applied in the current study because pre-tapping resulted in passive fixation since there is no self-threading pressure required. With most systems, self-tapping titanium screws required force to thread the bone during insertion with possibility for segment displacement.

The results support this finding, that the immediate post operative measurements showed no significant changes between both test groups while the inter gonial distance increased significantly along the follow up period in group I with no significant changes in group II.

In general, the symphysis, by allowing independent inversion and eversion of the two halves of the mandible during the masticatory power stroke, enables the steep occluding surfaces of opposing teeth to match during mastication, Goodship and Kenwright (1985); Kenwright and Goodship (1989); Liu and Herring (2000); Vinyard et al., (2006). These occluding forces could be considered to be the main factor of displacement in group I, because the masticatory mechanics resulted in inter-fragmentary micro-movement, Gates GN, Nicholls (1981). This movement facilitates elastic dental traction to detail

occlusion easily during the early postoperative period in group II, Turvey et al., (2011).

Over weight patients more than 90 Kg. excluded from the current study to avoid heavy biting forces that may lead to inaccurate results.

MMF concomitant with plate osteosynthesis help to strengthen fixation and correction of any minor segment displacement. The periods of MMF used with less rigid plates fixation varied considerably from one investigator to another, it ranges between 7 to 25 days, kim and Nam (2001); Bolourian et al., (2002). One week MMF period was selected to avoid lose of benefits of rigid fixation.

In conclusion, improper segment alignment or occlusal changes after open reduction of fractured mandible symphysis could be prevented by selecting or modifying the traditional line of treatment in order to establish stable proper occlusion. In the current study one week MMF with elastic traction recommended after symphyseal open reduction and fixation using PLA bone plates.

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11/11/2011