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International Journal of Current Research
Vol. 9, Issue, 03, pp.47620-47623, March, 2017

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

ISSN: 0975-833X

RESEARCH ARTICLE

EVALUATION OF BITE FORCES IN PATIENTS WITH MANDIBULAR FRACTURES TREATED WITH LOCKING MINIPLATES

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ARTICLE INFO

Article History:
Received 14th December, 2016
Received in revised form
20th January, 2017
Accepted 15th February, 2017
Published online 31st March, 2017

Key words:
Maximum voluntary bite force,
Locking plates and screws,
Champy's lines of Osteosynthesis,
Jaw muscles.

ABSTRACT

The treatment of mandibular fractures has been in a constant state of evolution with goals to restore function and occlusion. Among various treatment options of Open Reduction Internal Fixation (ORIF), locking miniplate system have advantages over conventional plating system. Bite force assesses masticatory muscle function under clinical and experimental conditions. The subject related factors includes-age, gender, periodontal support, height, weight, craniofacial morphology, malocclusion, temporomandibular disorder (TMD) pain. Therefore, bite force is used as a variable for evaluating masticatory function.

Citation: Dr. Bharat Prakash, M., Dr. Satya Bhushan, N.V.V., Dr. Siva Kalyan, U., Dr. Chiang, K.C., Dr. Srinivas Saketh, G. and Dr. Bramara Kumari, K., 2017. "Evaluation of bite forces in patients with mandibular fractures treated with locking miniplates", *International Journal of Current Research*, 9, (03), 47620-47623.

INTRODUCTION

Face, being the most admired point in the human body, any deviation, asymmetry and disfigurement due to trauma or by any other means would immensely affect an individual both physically and psychologically. The etiology of fractures of facial bone included mainly assaults and road traffic accidents. The treatment of mandibular fractures has been in a constant state of evolution with goals to restore function and premorbid occlusion. In the various treatment options of ORIF, locking miniplate system have advantages over conventional plating system. The various advantages of the locking plate system over the conventional plate are that the locking plate does not require precise adaptation of the plate to the underlying bone. A second advantage is that the screws are unlikely to loosen from the bone plate because the screws lock not only to the bone, but also to the plate and acts as a mini internal fixative. This study is designed to observe the maximum bite force following the treatment of mandibular fractures, with locking miniplates following the Champy's lines of osteosynthesis.

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MATERIALS AND METHODS

A total number of 30 patients who reported to the Department of Oral & Maxillofacial Surgery, GITAM Dental College & Hospital, Rushikonda, Visakhapatnam with mandibular fractures were included in the study. General demographics were noted. A detailed case history was taken and necessary blood investigations were advised with an informed consent from each patient. Inclusion criteria includes patients with mandibular symphysis, parasymphysis, body and angle fractures, non-compromised dentition and who are willing to participate in the study. Patients with condylar and subcondylar fractures, medical complications, pan facial or comminuted mandibular fractures, missing or loss of posterior teeth & those who need maxillomandibular fixation were excluded.

Procedure for Bite Force Recordings

The procedure involves a bite force meter which has a biting sensor. The individual is informed about the experimental procedure and the subject was seated comfortably in a chair in an upright position. A polythene sheet or a plastic wrapper was

used to cover the biting sensor. It is placed on the incisal edge of the anterior teeth for measuring anterior bite force (ABF) and then placed on the occlusal surface of the first molar on the right side for measuring the right posterior bite force (RBF) and then placed on the occlusal surface of the first molar on the left side for measuring the left posterior bite force (LBF). The subjects were asked to bite hard on the sensor and the maximum bite force reading on the charge meter display was recorded. Three such readings were taken, alternated on each side, with an interval of 1 minute to avoid muscular fatigue.

Position of the Patient and Operator

Surgical Procedure

The mandibular intra oral approach under local anesthesia using 2% lignocaine with 1:80000 adrenaline is used for treating the fractures. Necessary nerve blocks were given to maintain anesthesia and to reduce the hemorrhage during the surgical procedure. Intra oral bi-directional incision is given. Scalpel should be perpendicular to bone when incising above the mental foramen to prevent incision of the mental nerve. If incision is placed below or inferior to the mental foramen, chances of damage to the mental nerve branches. Controlled dissection and reflection of the mental neurovascular bundle facilitate retraction of the soft tissue away from the mandible.

Subperiosteal dissection up the anterior edge of the ascending ramus strips the buccinators attachments, which allows the muscle to retract upward, minimizing the chance of herniation of the buccal fat pad. Surgical site should stay within the periosteal envelope to prevent lacerating the facial vessels, which are just superficial to the periosteum. The fracture site is exposed and then 2mm thickness of 4 holed with gap stainless steel locking miniplates are placed using 2X8mm stainless steel locking screws 4 in number by using 1.5mm drill bit under copious saline irrigation at 2-3mm above the inferior border of the mandible and the other plate is placed at 5mm above the primary plate using 2X6mm stainless steel locking screws. A 2-layer closure is done, except posteriorly where a single layer closure is sufficient.

Pre-operative OPG

Post-Operative OPG

RESULTS

All the statistical data was collected and tabulated using ANOVA and Friedman tests. ANOVA, a parametric test was performed in all the variables and $p<0.01$ was accepted as statistically significant. By taking baseline measurements as reference, intra-group comparisions were made by using ANOVA test. Comparison of mean between the follow ups by using Friedman test. Comparison of mean among Pre op, 1 day, 1 week, 2 week, 4 week, 6 week & 8 week in Anterior bite force, right posterior bite force and left posterior bite force in the fractures on right side, left side, at the centre (Symphysis) and on both the sides by using Friedman test. The bite force in the anterior & posterior regions were significantly increased ($p<0.01$) from the immediate post op day to the end of 8^{th} week in 17 patients with fracture on the right side. It was observed that in 2 patients with the left mandibular fractures, the bite force in the anterior & posterior regions were increased from the immediate post op day to the end of 8 weeks which are statistically not significant. The bite force in the anterior & posterior regions were significantly increased ($p<0.01$) from the immediate post op day to the end of 8^{th} week in 9 patients with fracture on the both the sides (bilateral fractures). It was observed that in 2 patients with the symphysis mandibular fractures, the bite force in the anterior & posterior regions were increased from the immediate post op day to the end of 8 weeks which are statistically not significant. From all the above observations in this study, it can be concluded that patients treated with stainless steel locking miniplates for mandibular fractures irrespective of the site, the bite force has

increased from the pre op day to the end of 8th week in both anterior and posterior regions irrespective of statistical significance. None of the cases in the study had disturbed occlusion, deviation, hardware failure or presence of infection and wound dehiscence post operatively. It was also observed in the study that there was a gradual increase in the maximum mouth opening and lateral movements and decrease in pain from the pre operative to the end of 8th week.

DISCUSSION

Mandible is the largest, heaviest and strongest bone of the face. The normal mandible provides a normal airway and proper facial contour. A solid movable mandible allows normal chewing, swallowing and speech. Even though, it is a very strong structure, it is prone to injury, because of its prominent position in the facial skeleton. The mandible is the second most commonly fractured part of the maxillofacial skeleton because of its position and prominence. The location and pattern of the fractures are determined by the mechanism of injury and the direction of the vector of the force. In addition to this, the patient's age, the presence of teeth, and the physical properties of the causing agent also have a direct effect on the characteristics of the resulting injury. In the management of any bone fracture, the goals of treatment are to restore proper function by ensuring union of the fractured segments and re-establishing pre-injury strength; to restore any contour defect that might arise as a result of the injury; and to prevent infection at the fracture site. Champy *et al*. (1978) modified miniplates to make it clinically more applicable and developed the concept of osteosynthesis. Champy advocated the transoral placement of small, thin, malleable, stainless steel miniplates with monocortical screws along an ideal osteosynthesis line of the mandible. Champy believed that compression plates were unnecessary because of masticatory forces that produce a natural strain of compression along the inferior border. Biomechanical studies of Champy *et al*. resulted in the concept of an ideal line of osteosynthesis as these studies have found distraction of the lower border of the mandible when vertical loading forces are applied close to the fracture line (Jain, 2014).

In conventional bone plate/screw system, the plate must be perfectly adapted to the underlying bone to prevent alterations in anatomically fractured fragments. There have also been incidents of loosening of one or more screws during the convalescence period, resulting in changes in occlusal relationship. This problem, to an extent, has been overcome by the development of locking plate/screw systems where the screw locks not only the bone but also the plate and serves as a mini‑internal fixator. It is assumed that this relationship of plate and screw will reduce the number of fixation screws per osseous fragment and thus, minimal hardware can achieve the same fixation objectives as with bulkier plating systems (Kumar, 2014). Gutwald R[30], introduced a mini-locking-system which was designed according to the UniLOCK 2.4 system but was of more delicate form. The first biomechanical comparison of locking plates to appear in the maxillofacial surgical literature was also made by Gutwald R[30].The stability of this locking screw plate system was three times higher than conventional miniplates which was observed in an in vitro trial study done by Gutwald R *et al* (Lieger *et al*., 2015). Mechanical analysis of internal fixation techniques are acquiring importance, since they have helped to qualify, develop and determine the potential of fixation materials for clinical use (Singh, 2011). Saurab *et al* (Kumar *et al*., 2014) found that patients treated with locking plate or screw system generated more bite force than conventional miniplate / screw system. V.Singh *et al*, Chad P. Collins *et al*, Ralf *et al*, Arpit *et al*, found that miniplate locking system showing a higher stability than conventional mini plate system which is in coherent with this study. The main advantage of locking plate over the conventional plate is that the LMP does not require precise adaptation of the plate to the underlying bone. As the screws are tightened, they "lock" to the plate, thus stabilizing the segments without the need to compress the plate to the bone. A second advantage of locking plate/screw system is that the screws are unlikely to loosen from the bone plate even if the screw is inserted into the fracture gap or a comminuted segment; hence, there is decreased incidence of inflammatory complications from loosening of the plate and screws. One more potential advantage in locking plate/screw system is that it does not disrupt the underlying cortical bone perfusion or the vascular supply of bone, and allows the periosteum to grow under the plates, supporting fracture healing. Cortical necrosis, which is observed in compression plates, is not noticed in locking plates since the plate gains its rigidity by locking the screw rather than by being compressed against the bone. To gain adequate stability, the locking plate need not be compressed or adapted against the underlying bone; thus, stripping and loosening of the screws is not noticed in this system.

The locking system negates the disadvantages of the conventional system. There is minimal interference with underlying cortical vascular supply and primary stability provided by the "internal fixator" is greater than that obtained in the conventional system. In this study, the bite force measurement method was first demonstrated to the subjects after they were seated comfortably in a dental chair in an upright position. A disposable plastic sleeve was used to cover the sensor assembly and placed on the occlusal surface of the first molar. The subjects were asked to bite hard on the sensor and the peak bite force reading on the charge meter display was recorded. Three such readings were taken, alternated on each side, with an interval of 3 min to avoid muscular fatigue. To reduce the error and bias in study single operator has filled the proforma and recorded the bite force in all subjects which is in coherent with the study done by Veena Jain *et al*. Parasymphysis fracture was the most commonly involved site when compared to other fracture sites in the study which is in coherent with the study of Agarwal M *et al* (Vashistha *et al*., 2016). There were no intra operative difficulties such as screw being not locked with the plates, in the utilisation of the locking plate/ locking plate system in the treatment of fractures in this study which is in coherent with the study done by Saurab kumar *et al* (Kumar *et al*., 2014). According to the Ayman Chritah *et al* (Gerlach *et al*., 2002), 2mm LMP were adapted along the Champy's line of ideal osteosynthesis secured with four 2X8mm locking monocortical screws, which is in coherent with the present study.

According to the study done by Rajesh Kshirsagar *et al* they found that the mean of maximum bite force in molar region were 36kg and in incisor region 15kg in adult healthy individuals. In this study, there is a trend of increase of bite force in both incisor and molar region from the pre-operative day to the end of 8th week in all the 10 patients with 13 mandibular fractures, which is incoherence with the study done by Rajesh Kshirsagar (Kshirsagar *et al*., 2011). In this study,

incisor bite forces in symphysis fractures, were increased significantly from pre-op day to 8th week, which is incoherence with the studies by Rajesh Kshirsagar and Saurab *et al*. According to Saurabh Kumar *et al*, after application of locking plates in mandibular fractures at the symphysis region, the mean bite force has increased which is in coherent with the present study.

Conclusion

- There was a gradual increase in maximum bite force both in the incisor and molar region, from the pre-operative day to the end of 8th week in mandibular fractures treated with 2mm locking miniplates proving that the post-operative masticatory efficiency was increased substantiating that there is better stability of the fractured fragments of mandibular fractures when treated with 2mm locking miniplates in all the cases.
- Maximum mouth opening and maximum lateral movements had gradually increased from the pre-operative day to the end of 8th week.
- There were no clinical post-operative complications such as wound dehiscence and infection and radiographic complications such as hardware failure in this study.

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