

EVALUATION OF BONE REDUCTION FORCEPS IN TREATMENT OF MANDIBULAR FRACTURE (A PROSPECTIVE CLINICAL AND RADIOGRAPHIC STUDY)

Ola Ibrahim M. Zeina BDS^{1*}, Mervat Mohamed Khalil PhD², Gaafar Nabil Ahmed El-Halawani PhD³

ABSTRACT

INTRODUCTION: Mandibular fracture treatment aims to achieve adequate reduction of the fracture fragments and immobilize these fragments firmly to restore preinjury occlusion. With a repositioning forceps, an accurate anatomical reduction and better alignment of the fragments occurs that favors bone healing and diminish risks of complications.

OBJECTIVES: Evaluation of the effect of using bone reduction forceps in treatment of mandibular fractures clinically and radiographically.

MATERIALS AND METHODS: A prospective study was done on ten patients complaining of displaced isolated mandibular fractures. Fracture reduction was done using bone reduction forceps then fixation by miniplates and screws. The patients were followed up clinically for 3 months postoperatively evaluating pain, facial edema, occlusal disturbances, maximal mouth opening and wound healing. Radiographic evaluation was performed by computed tomography preoperatively, and cone beam computed tomography was done after 3 and 6 months postoperatively. The results were calculated and statistically analysed to indicate the efficacy of using the forceps in treatment of displaced mandibular fracture.

RESULTS: Clinically, all parameters evaluated were statistically significant along the follow up period (p value ≤ 0.05) except for pain that was only significant at 6th and 12th week in comparison to that of the first week. Radiographically, postoperative CBCT showed an increase in bone density in fracture site, the results were statistically significant at 3 and 6 months postoperatively as p value < 0.0001 .

CONCLUSION: Using bone reduction forceps followed by semi-rigid fixation by miniplates was easy and safe for the treatment of isolated mandibular fractures with small number of major complications.

KEYWORDS: Mandible, Fracture, Reduction Forceps, Open fracture treatment.

RUNNING TITLE: Treatment of mandible fracture by bone reduction forceps.

1 Bachelor of Dental Surgery, Faculty of Dentistry, Alexandria University, Alexandria, Egypt.

2 Professor of Oral and Maxillofacial Surgery Department, Faculty of Dentistry, Alexandria University, Alexandria, Egypt.

3 Lecturer of Oral and Maxillofacial Surgery Department, Faculty of Dentistry, Alexandria University, Alexandria, Egypt.

*Corresponding author

E-mail: oladent13@gmail.com

INTRODUCTION

Mandibular fractures are among the most common injuries to the facial skeleton. The goal of treatment of mandible fractures should be to return the patient to a preinjury state of function and aesthetics (1).

Mandibular fracture treatment aims to achieve adequate reduction of the fracture fragments, to immobilize these fragments firmly in order to restore preinjury occlusion and to promote direct bone healing. Common methods for reduction of mandibular fractures include intermaxillary fixation (IMF), manual reduction, and the use of a repositioning forceps. After adequate reduction, the aligned fragments are fixed with osteosynthesis materials. IMF is used primarily to restore occlusion and secondarily to reduce the fracture (2, 3).

Commonly, IMF is applied by wiring the upper and lower jaws with the arch bars, but there is a variety of alternative techniques including IMF screws. Although shown to be successful, the various IMF techniques have

drawbacks including an increased risk of root injury, IMF screw failure, accidental needle stick injury, and discomfort to the patient (4-6).

In comparing different modalities of reduction, when performing manual reduction, extra hands to reduce the fracture fragments are needed, preferably with aid of a skilled assistant. With a repositioning forceps, a more accurate anatomical reduction and higher pre-compression can be achieved compared to IMF or manual reduction. This better alignment and compression of the fragments is presumed to favor bone healing and diminish risks of complications (3).

All above mentioned mandibular fracture reduction techniques are viable options for treatment of mandibular fractures. In clinical practice, these techniques are often used in combination with each other (7).

The main objective of this study was to evaluate the outcome of treating mandibular fractures using bone reduction

forceps as an aid to obtain accurate bone and teeth alignment in order to attain predictable and favorable outcomes.

MATERIALS AND METHODS

Appropriate ethical clearance was obtained from the Faculty of Dentistry, Alexandria University and an informed consent was obtained from the participant patients. This manuscript was registered in www.clinicaltrials.gov, identifier: NCT04443998.

Patients

Study Design

A prospective study was conducted on a total number of 10 adult patients, who were suffering from isolated mandibular fractures which were not infected, nor comminuted. All patients were selected, admitted and were operated in Oral and Maxillofacial surgery department, Faculty of Dentistry, Alexandria University, Egypt. All patients had assigned an informed consent before they had been operated. This research had been approved by the research ethics committee of Faculty of Dentistry, Alexandria University, Egypt.

Inclusion criteria

Adult patients aged from 20 to 45 years were included.

Patients suffered from recent and uninfected fracture.

Patients with isolated mandibular fractures.

Exclusion criteria

Medically compromised patients that will be not fit for surgery.

Edentulous patients.

Non-displaced

Comminuted fracture with bone loss

Old fracture, more than 3 weeks

Materials

1. Titanium miniplates with 2.0 mm holes and screws system. (KLS Martin Group, Tuttlingen, Germany)

2. Bone reduction forceps. (W.A & SONS bone reduction clamp, Pakistan)

Methods

Pre-Operative Evaluation

History

Personal history

Obtaining full personal data was done including name, age, gender, occupation, address, telephone number, past medical and dental history. In addition to the name, address and telephone number of the companions.

Chief complaint

All details about the trauma was recorded, including cause, time, date, place and type of assault will be done.

General examination

It consists of general state of health, associated body injury, any soft tissue laceration, patients' conscious state and first aid management.

3. Clinical examination

A. Extra-oral examination

Inspection: including swelling, ecchymosis, facial deformity and soft tissue laceration.

Palpation: any step deformity, tenderness, bony crepitus, condylar movements during opening and closing, and altered lip sensation (indicating inferior alveolar nerve injury) was assessed.

B. Intraoral examination

Inspection: including lingual hematoma, teeth integrity, and occlusal derangement.

Palpation: of buccal and lingual sulci for the presence of tenderness or alteration in contour. Bimanual manipulation of the mandible was done on either side of the suspected fracture to detect any abnormal mobility.

4. Radiographic examination

Radiographic evaluation was performed by computed tomography (CT) preoperatively.

Radiological findings include: fracture site, degree of fracture displacement, presence of tooth in the fracture line, and presence of additional fractures.

Preoperative patient preparation

All patients were instructed to perform oral hygiene measures.

Preparation for operation under GA

Complete evaluation was done for medical and post traumatic status including monitoring vital signs.

Routine preoperative laboratory investigations (complete blood count, Clotting time, Bleeding time, Prothrombin time and activity, Liver and kidney functions and fasting blood sugar) were done.

Amoxicillin 875 mg + Clavulanic acid 125 mg, manufactured by GlaxoSmithKline, UK. It was given every 12 hours as a prophylactic therapy to prevent postoperative infection.

All patients signed a preoperative Informed Consent before undergoing the operation to ensure and confirm their understanding of the outcome of the operation and the risks they might be subjected to during the intervention.

Patients were instructed about at least 8 hours of fasting prior to surgery.

Operative Procedures

1. General Anesthesia

All patients were operated upon under general anaesthesia using nasotracheal intubation.

A pack was applied to prevent any blood, saline and foreign bodies to fall in the airway.

Patient was put in a hyper-extended neck position after ensuring that patient does not have a cervical spine fractures.

Disinfection, Draping and Towelling Preliminary assessment of occlusion and application of eyelets or IMF screws to be used for maxillomandibular (MMF) if needed. A vestibular intraoral incision was made followed by reflection of mucoperiosteal flap till reaching the lower border of the mandible to adequately expose the fracture. (fig. 1 A)

Maxillo-mandibular fixation (MMF) will be temporarily secured if needed to provide proper occlusion that serves as a guide for fracture reduction (fig.1 B). IMF was removed at the end of the surgery.

The fracture was mobilized to remove any soft tissue entrapment and the fractured segments were reduced into proper anatomical position, with the aid of bone reduction forceps. Bone reduction forceps was applied after drilling of two monocortical holes in basal mandibular bone (5-8 mm on each side of the fracture measured using a ruler) using surgical drill under constant saline irrigation.

The reduction forceps was then placed into these holes and the fragments were compressed together. (fig. 1 C)

After the application of the bone reduction forceps, the fragments reduction was checked by inspection of the lower border continuity at first followed by its palpation by passing a tipped instrument (e.g., periosteal elevator) along the fracture line and the lower border of the fractured part of the mandible.

The occlusion was checked before the fixation with a miniplate was carried out.

Adaptation of miniplates along Champy's line of ideal osteosynthesis followed by drilling of the screw holes, secured with monocortical screws was done. (fig. 1 D)

The area was irrigated with Betadine and saline after adequate hemostasis was achieved then closure of the wounds in layers was done using resorbable sutures without drains.

Postoperative care

- Each patient had received Augmentin (Augmentin: Amoxicillin 875 mg + Clavulanic acid 125mg, manufactured by MPU.) 1 gm twice daily for 7 days.
- Analgesic anti-inflammatory drug in the form of Rheumafen (Rheumafen: Diclofenac Sodium 75mg/2ml amp. by GlaxoSmithKline.) 75 mg vial till the second postoperative day followed by Cataflam (Cataflam: Diclofenac Potassium 50mg. by Novartis.) 50 mg tablets three times daily.
- All patients were instructed to use Betadine mouth wash (by Mundipharma AG, Switzerland) for maintenance of good oral hygiene.
- Instruction of soft diet for all patients for 4 weeks postoperatively.
- Patients were instructed for application of cold fomentation on the extraoral surgical site for 10 min/1 hour in the first postoperative day, followed by hot fomentations for 10 min/1 hour starting from the second postoperative day.

Follow up

Clinical follow up: was scheduled at 1 week, 2 weeks, 1 month, 6 weeks, and 3 months.

Clinical Parameters

Pain: was evaluated on Visual Analogue Scale (VAS). The patients were asked to rate their postoperative pain on a 4-point scale as follows: (0= none, 1= slight, 2= moderate, 3= severe).

Facial edema: will be determined using a measuring tape. Three measurements were made between 5 reference points: tragus, soft tissue pogonion, lateral corner of the eye, angle of the mandible, and outer corner of the mouth, preoperatively, and on the second and seventh postoperative days. The preoperative sum of the 3 measurements was considered as the baseline for that side. The difference between each postoperative measurement and the baseline indicates the facial swelling for that day.

Maximal mouth opening: maximal interincisal opening between maxillary and mandibular central incisors was measured.

Surgical wound: was assessed for signs and symptoms of infection including swelling, redness,

hotness, discharge, and pain in addition to observation for any manifestations of wound healing disturbance.

Occlusion: was checked in the maximal intercuspal position (centric occlusion) to ensure proper occlusal relationship including molar relation and midline centralization. Any occlusal disturbance including open bite or improper tooth contact was pointed out.

Radiographic follow-up

Cone beam computed tomography (CBCT) was performed at 3 months and at 6 months postoperatively to evaluate

The adequacy of the reduction of the fractured segment.

The progress of healing process.

The mean bone density at the site of the fracture line.

Statistical analysis

Data was fed to the computer and analyzed using International Business Machines Statistical Package for the Social Sciences (IBM SPSS) software package version 25.0. (Armonk, NY: IBM Corp). Qualitative data were described using frequency and percentage. Quantitative data were described using range (minimum and maximum), mean, standard deviation and median.

The used tests were:

Normality was checked using Shapiro Wilk test.

Change in pain scores was assessed using Friedman test followed by pair wise comparisons.

Percent change in edema measurements and bone density at 3 and 6 months was compared using Paired t test.

Edema measurements and maximum mouth opening was compared across time by One Way Repeated Measures ANOVA.

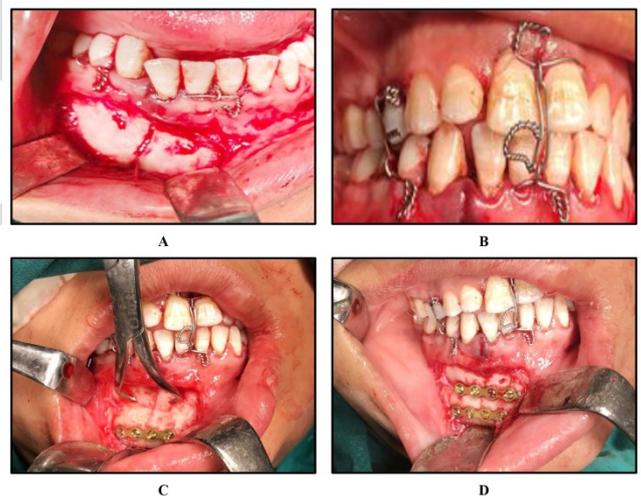


Figure (1): (A) Clinical photograph showing right displaced mandibular parasymphysal fracture, (B) showing gaining IMF, (C) showing bone reduction forceps in place and application of single miniplate adapted and fixed to the reduced fracture and (D) showing final situation after application of the 2 miniplates and screws.

RESULTS

This study was performed on ten patients, including seven males and three females, who complained from isolated mandible fracture. It was conducted in the Oral and

Maxillofacial Surgery Department, Faculty of Dentistry, Alexandria University. The patients were selected according to inclusion and exclusion criteria for this study. The age was ranging from 22 to 39 years old with mean age 27.6 years old. The cause of fracture was Road traffic Accident (RTA) =70% and Alleged Assaults (AA) =30%. Four patients had right parasymphiseal fracture (40%), three patients had left parasymphiseal (30%), two patients had right body fracture (20%) and only one patient had left body fracture (10%).

Clinically, all cases showed stability of the bony segments in the normal position, no mobility of the bony segments was detected. No signs of infection or suppuration were observed. All cases were able to maintain good oral hygiene by the conventional means through tooth brushing and the use of warm normal saline as a mouthwash.

Regarding the pain, where pain intensity score scaled from 0 (No pain) to 3 (Most severe pain). It was found that results were statistically significant in the 6th and 12th week in comparison to the first week as p value ≤ 0.05. (Table 1)

The pain score through the 1st week was (2) for seven cases and (3) for three cases.

The pain score through the 2nd week was (2) for seven cases and (3) for three cases.

The pain score through the 4th week was (2) for one case, (1) for five cases and (0) for four cases.

The pain score by the end of the 6th week and the 12th week was (0) for all cases.

Regarding the facial edema at the fracture site preoperatively, 2nd postoperative day and 7th postoperative day where the facial edema valued by using 3 lines measurements along 5 fixed points it was found that: (Table 2)

The mean facial edema score preoperatively was (32.60) with SD ±(2.40) cm

The mean facial edema score on 2nd postoperative day was (35.05) with SD ± (2.98) cm

The mean facial edema score on 7th postoperative day was (29.30) with SD ± (2.00) cm

The results were statistically significant at p value p<0.0001*.

Regarding the occlusal disturbances, all patients showed normal occlusion and inter-cuspal relations of the teeth with no need for selective grinding

Regarding the wound healing, it went uneventful for all cases in surgical sites and no infection nor wound dehiscence were detected.

Regarding the maximal mouth opening, all cases turned to their normal maximum mouth opening by the end of the follow up period. (Table 3)

The maximal inter-incisal opening was measured between maxillary and mandibular central incisors using a ruler after one week, 2 weeks, 4 weeks, 6 weeks and 3 months.

1st week postoperatively: The mean value of maximum mouth opening score was 20.00± 3.05 mm.

2nd week postoperatively: The mean value of maximum mouth opening score was 25.90 ± 5.06 mm which was statistically significant when compared to the baseline as p value =0.001 (p ≤ 0.05).

4th week postoperatively: The mean value of maximum mouth opening score was 31.60±5.21 mm which was statistically significant when compared to the baseline as p value <0.0001 (p ≤ 0.05).

6th week postoperatively: The mean value of maximum mouth opening score was 37.50±3.72 mm which was statistically significant when compared to the baseline as p value <0.0001 (p ≤ 0.05).

3rd month postoperatively: The mean value of maximum mouth opening score was 38.30±3.68 mm which was statistically significant when compared to the baseline as p value <0.0001 (p ≤ 0.05).

Evaluation of bone density

After 3 months, the CBCT showed stable fracture segments in all patients. After 6 months, the CBCT showed good healing at the fracture sites. (Fig. 2) Bone Density measurement icon was used at the region of interest (ROI) to give a value in a gray scale (3 points at each ROI). The mean bone density at the site of fracture was calculated by measuring the bone density at 3 points distributed inside the fracture line then taking their mean value to determine the mean bone.

After 3 months: The mean bone density in this study was 606.41±96.02 voxel value (VV).

After 6 months: The mean bone density in this study was 964.23±92.49 VV.

The percentage change in the bone density from 3 to 6 months postoperative was statistically significant as p value <0.0001 (p ≤ 0.05).

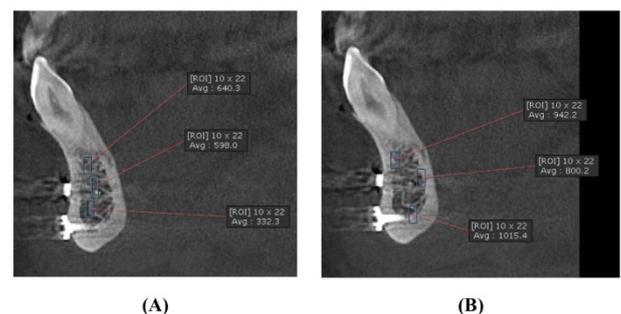


Figure (2): (A) Postoperative CBCT after 3 months showing progress of healing (B) Postoperative CBCT after 6 months showing progress of healing.

Table (1): Pain scores in the study participants at different time intervals

| | 1 week | 2 weeks | 4 weeks | 6 weeks | 12 weeks |
|-----------|-------------|-------------|-------------|---------|----------|
| Mean (SD) | 2.30 (0.48) | 1.70 (0.48) | 0.70 (0.68) | 0 (0) | 0 (0) |
| Median | 2.00 | 2.00 | 1.00 | 0 | 0 |
| Minimum | 2 | 1 | 0 | 0 | 0 |
| Maximum | 3 | 2 | 2 | 0 | 0 |
| P value | <0.0001* | | | | |

*Statistically significant difference at p value ≤0.05

Table (2): Edema measurements in the study participants at different time intervals

| | Baseline | 2 nd day | 7 th day |
|-----------|--------------|---------------------|---------------------|
| Mean (SD) | 32.60 (2.40) | 35.05 (2.98) | 29.30 (2.00) |
| Median | 2.00 | 2.00 | 1.00 |
| Minimum | 29.0 | 31 | 27 |
| Maximum | 36.5 | 41 | 32 |
| P value | <0.0001* | | |

*Statistically significant difference at p value ≤ 0.05

Table (3): Maximum mouth opening measurements in the study participants at different time intervals

| | 1 week | 2 weeks | 4 weeks | 6 weeks | 12 weeks |
|-----------|--------------|--------------|--------------|--------------|--------------|
| Mean (SD) | 20.00 (3.05) | 25.90 (5.06) | 31.60 (5.21) | 37.50 (3.72) | 38.30 (3.68) |
| Median | 20.00 | 24.50 | 30.00 | 37.50 | 38.00 |
| Minimum | 15 | 20 | 25 | 30 | 31 |
| Maximum | 26 | 38 | 42 | 42 | 42 |
| P value | <0.0001* | | | | |

*Statistically significant difference at p value ≤ 0.05

DISCUSSION

Management of mandibular fractures is one of the most demanding and continuously evolving field that maxillofacial surgeon deals with. Regaining pre-morbid occlusion and providing immediate uncompromised functional stability are the main points that must be put in mind during mandibular fracture management. Stable fixation schemas are mandatory for promoting primary bone healing, minimize interfragmentary strain, obtaining immediate postoperative functional stability, eliminating the postoperative MMF period and decreasing the incidence of infection (8).

Batbayar et al., (9) stated that the usage of reduction forceps has been known for many years in general trauma surgery, orthopedic surgery and plastic surgery. In Oral and Maxillofacial surgery, the dental occlusion was used to perform and check reduction of mandibular fractures. Notwithstanding this historical background, reduction forceps can be used in mandibular fractures as in any other fracture as long as there is sufficient space and as long as the fracture surface permits stable placement and withstands the forces created by such a forceps.

Choi et al., (10) stated that symphyseal and parasymphiseal fractures were rather easy to reduce with reduction forceps due to their curved shape. However, mandibular angle fractures are more challenging to reduce due to the difficulty of positioning the forceps intraorally. Therefore, a specific reduction forceps was designed for fractures of this area by bending one prong for inserting into a hole on the proximal fragment medial to the oblique line and the other prong was used for inserting into a hole on the distal fragment below the oblique line. So, our study included patients having symphyseal, parasymphiseal and body fracture so as to facilitate the clamp application.

Patients who were included in the present study were lying within the age group 22 - 39 years old. The mean age was 27.60 ± 5.93 years old which is higher than Sakr et al., (11) who reported a mean age of 22 years but lower than Bergh et al., (12) and da Silva et al., (13) who reported a mean age of 32. It is thought that this result is due to the fact that young adults represent a large mass in our country and they actively participate in outdoor activities without submitting to safety rules like seat belts in cars and wearing helmets when riding motorbikes.

In our study, road traffic accidents were found to be the most frequent cause of fractures accounting for 70 % of the cases which was in agreement with Sakr et al., (11) and with Sirimaharaj and Pyungtanasup (14).

In this study, 70% of the patients were males while 30% were females which indicated that the male ratio was higher than females. The higher frequency of maxillofacial injuries among men compared to women in the present study may be attributed to the fact that the females drive vehicles less frequently and more carefully than males. This result was supported by Tripathy et al., (15) and Czerwinski et al., (16).

In the current study, ten patients were selected with isolated mandibular fractures as it is postulated that an additional mandibular fracture may act as a confounding variable and thus affect the treatment outcome. This is consistent with the recommendations of Barry and Kearns (17) who suggested that a second fracture may contribute to instability at fracture site, leading to impaired bone healing, predisposing to infection, or malocclusion. Thus the isolated mandibular fracture allows us to establish the true complication rate for these fractures.

Across the follow up period, all the cases experienced a decrease in level of pain intensity score based on the Visual Analogue Scale (VAS), where the mean score at first week postoperative follow up was 2.30 ± 0.48 , which is equivalent to the base line level of the subjective pain sensation. This value showed an insignificant decrease ($p=1$) to become 1.70 ± 0.48 at the second week postoperative follow up, then an insignificant difference ($p=0.058$) at the four weeks postoperative follow up 0.70 ± 0.68 , and then a significant difference ($p=0.0001$) at the six weeks postoperative follow up. The overall decline in the recorded pain scores across the follow up period was statistically significant ($p<0.001$). This is a rational assumption considering that adequate stabilization of the bone fragments across the fracture line will eliminate pain and discomfort of the patient.

Bhatnagar et al., (2013) (18) showed a similar statistically significant decrease in the documented pain scores across the follow up span where our results for this study were found to be statistically significant in the 6th and 12th week in comparison to the first week as p value ≤ 0.05 .

Batbayar et al., (2017) (9) showed that the application of reduction forceps can make IMF unnecessary and so reduces operation time. Additionally, with respect to the patient, IMF-related complications such as gingivitis, pain, discomfort or difficulties in maintaining oral hygiene and root injury by IMF screws are diminished

by avoiding IMF. Treating patients without IMF could reduce the risk of injury or infection of the surgeons and nursing staff and decreases the number of assistants as well.

Choi et al., (3) Scolozzi and Jaques (19) and Shinohara et al., (20) have shown that reduction forceps could significantly reduce operation time, and their use results in adequate bone fragment reduction and causes few postoperative complications such as infection and occlusal disturbance. This finding was in agreement with our results where operation time does not exceed 45 minutes in case of using bone reduction forceps and miniplates with no other means of IMF.

Choi et al., (3) described operation times as being significantly reduced in the reduction forceps group; the average operation time was 41 minutes in the forceps group compared to 87 minutes in the IMF group. The facial edema at the surgical site subsided by the 7th postoperative day all the participants. There were statistically significant difference between the measurements preoperatively and postoperatively. This result agrees with El-Gengehi and Seif (2015) (21).

All cases had no disturbances in occlusion postoperatively, so there was no need for selective grinding in any case. This is consistent with the literature in which clinical studies investigating using the bone reduction forceps showed that the occurrence of occlusal changes was 0% as Choi et al., (2005) (3), Scolozzi and Jaques (2008) (19) stated that none of the patients complained of postoperative occlusal discrepancies when using bone reduction forceps for reducing mandible fractures.

Regarding the assessment of surgical wound, healing went uneventful for all cases in both surgical sides and no infection nor wound dehiscence were detected. Also, this result goes along with Kluszynski et al., (2015) (22). All of the patients were given prophylactic preoperative antibiotics and were put on a postoperative antibiotic regime for five days. Shridharani et al., (2015) (23) noted as low as 1.1% of postoperative infection following ORIF when the subjects were put under postoperative antibiotic course. Following a strict infection control protocol and aseptic intraoperative techniques have their role in the reduction of the number of cases with postoperative infection.

Inter-incisal measurements showed a statistically significant increase across the follow up span ($p < 0.001$). By the end of the three months follow up period, the mean inter-incisal distance recorded 38.30 ± 3.68 . This result agrees with Holaiel et al., (2017) (24). Niezen et al., (2015) (25) reported a similar percentage of increase, however he reported higher readings in millimeters than this study. The early return to work and normal function is one of the main advantages of the ORIF over the closed reduction treatment modality as well as the decrease in the probability of muscular atrophy as Eckelt et al mentioned (26).

Several studies have shown that reduction forceps could significantly reduce operation time, and their use results in adequate bone fragment reduction and causes few postoperative complications such as infection and occlusal

disturbance (3,19). This finding was in agreement with our results.

Regarding the bone density, cone beam CT was done postoperatively at 3 and 6 months. Bone density was measured in the vicinity of the fracture line using the CBCT software. Three readings were taken each time and then the average was calculated to determine the mean bone density.

The present study showed that the mean bone density in proved to be statistically significant throughout the follow up period, the percentage change in the bone density from 3 months to 6 months postoperative was statistically significant as p value < 0.0001 ($p \leq 0.05$). This result is consistent with the progress of fracture bone healing.

Shinohara et al., (2006) (20) stated that surgeons must pay attention to lingual site gapping when using reduction forceps, because it could cause separation of lingual borders of the mandible. However, this finding was in agreement with our clinical trial in only two patients but it was not noticeable at the end of the follow up and the progress of the healing progress.

Although this method shows plenty of advantages, still this study has some limitations. First, the current study is based on a small sample size, hence the need for a further research with larger sample size to comprehensively advocate the outcomes with less bias. Second, two groups are needed to compare between the outcome of mini plate assisted by reduction forceps versus without. Third, the current report did not focus on evaluation of biomechanical parameters as measuring force provided by the bone reduction forceps. Accordingly, we need to address a prospective clinical and radiographic study including larger sample size with superadded biomechanical study.

CONCLUSION

Using bone reduction forceps followed by semi-rigid fixation by miniplates is an easy and safe method for the management of isolated mandibular fractures with approximately lack of major complications.

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

FUNDING STATEMENT

The authors received no specific funding for this work.

REFERENCES

1. Punjabi AP, Herford AS. Mandibular Fractures. In: Thaller SR, McDonald WS (eds). Facial Trauma. New York: Marcel Dekker; 2004. p. 381.
2. Mukerji R, Mukerji G, McGurk M. Mandibular fractures: Historical perspective. *Br J Oral Maxillofac Surg.* 2006;44:222-8.
3. Choi BH, Kim HJ, Kim MK, Han SG, Huh JY, Kim BY, Zhu SJ, Jung JH. Management of mandibular angle fractures using the mandibular angle reduction forceps. *Int J Oral Maxillofac Surg.* 2005;34:257-61.
4. Dimitroulis G. Management of fractured mandibles without the use of intermaxillary wire fixation. *J Oral Maxillofac Surg.* 2002;60:1435-8.

5. Bali R, Sharma P, Garg A. Incidence and patterns of needlestick injuries during intermaxillary fixation. *Br J Oral Maxillofac Surg.* 2011;49:221-4.
6. Hashemi HM, Parhiz A. Complications using intermaxillary fixation screws. *J Oral Maxillofac Surg.* 2011;69:1411-4.
7. Batbayar EO, Malwand S, Dijkstra PU, Bos RRM, van Minnen B. Accuracy and outcome of mandibular fracture reduction without and with an aid of a repositioning forceps. *Oral Maxillofac Surg.* 2019;23:201-8.
8. Luhr HG. The development of modern osteosynthesis. *MKG* 2000;4:S84-90.
9. Batbayar EO, van Minnen B, Bos RRM. Non-IMF mandibular fracture reduction techniques: A review of the literature. *J Craniomaxillofac Surg.* 2017;45:1327-32.
10. Choi BH, Suh CH, Par JH, Yoo JH, Kim HJ. An effective technique for open reduction of mandibular angle fractures using new reduction forceps: technical innovations. *Int J Oral Maxillofac Surg.* 2001;30:555-7.
11. Sakr K, Farag IA, Zeitoun IM. Review of 509 mandibular fractures treated at the University Hospital, Alexandria, Egypt. *Br J Oral Maxillofac Surg.* 2006;44:107-11.
12. Van den Bergh B, Heymans MW, Duvekot F, Forouzanfar T. Treatment and complications of mandibular fractures: a 10-year analysis. *J Craniomaxillofac Surg.* 2012;40:e108-11.
13. da Silva NF, da Graça Naclerio-Homem M, Borba AM, Borges ÁH, Semenoff-Segundo A. Epidemiological analysis of facial fractures. *J Dent.* 2015;2:1-4.
14. Sirimaharaj W, Pyungtanap K. The epidemiology of mandibular fractures treated at Chiang Mai University Hospital: A review of 198 cases. *J Med Assoc Thail.* 2008;91:868-74.
15. Tripathy NK, Jagnoor J, Patro BK, Dhillon MS, Kumar R. Epidemiology of falls among older adults: A cross sectional study from Chandigarh, India. *Injury.* 2015;46:1801-5.
16. Czerwinski M, Parker WL, Chehade A, Williams HB. Identification of mandibular fracture epidemiology in Canada: Enhancing injury prevention and patient evaluation. *Can J Plast Surg.* 2008;16:36-40.
17. Barry CP, Kearns GJ. Superior border plating technique in the management of isolated mandibular angle fractures: a retrospective study of consecutive patients. *J Oral Maxillofac Surg.* 2007;65:1544-9.
18. Bhatnagar A, Bansal V, Kumar S, Mowar A. Comparative analysis of osteosynthesis of mandibular anterior fractures following open reduction using 'stainless steel lag screws and mini plates'. *J Maxillofac Oral Surg.* 2013;12:133-9.
19. Scolozzi P, Jaques B. Intraoral open reduction and internal fixation of displaced mandibular angle fractures using a specific ad hoc reduction-compression forceps: a preliminary study. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod.* 2008;106:497-501.
20. Shinohara EH, Mitsuda ST, Miyagusko JM, Horikawa FK. Mandibular fracture reduction without intraoperative intermaxillary fixation: A technique using two modified reduction forceps. *J Contemp Dent Pract.* 2006;7:150-6.
21. El-Gengehi M, Seif SA. Evaluation of the Accuracy of Computer-Guided Mandibular Fracture Reduction. *J Craniofac Surg.* 2015;26:1587-91.
22. Kluszynski BA, Wineland AM, Kokoska MS. Mechanical and clinical rationale of prototype bone reduction forceps. *Arch Facial Plast Surg.* 2007;9:106-9.
23. Shridharani SM, Berli J, Manson PN, Tufaro AP, Rodriguez ED. The role of postoperative antibiotics in mandible fractures: a systematic review of the literature. *Ann Plast Surg.* 2015;75:353-7.
24. Holaiel WN, Elprince N, Fahmy MH. Matrix Miniplate versus locking miniplate in the management of displaced mandibular angle fractures. *Int J Sci Res.* 2017;6:261-9.
25. Niezen E, Stuive I, Post W, Bos R, Dijkstra P. Recovery of mouth-opening after closed treatment of a fracture of the mandibular condyle: a longitudinal study. *Br J Oral Maxillofac Surg.* 2015;53:170-5.
26. Eckelt U, Schneider M, Erasmus F, Gerlach KL, Kuhlisch E, Loukota R, et al. Open versus closed treatment of fractures of the mandibular condylar process—a prospective randomized multi-centre study. *J Craniomaxillofac Surg.* 2006;34:306-14.