Evaluation of Condylar Position after ORIF of Anterior Mandibular Fractures Using 3 Dimensional Miniplate Versus Conventional Miniplates: A Randomized Clinical Trial

Original Article

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ABSTRACT

Purpose: This study aimed to compare radiographically and clinically the single 3-D miniplate and the conventional two miniplates in ORIF of anterior mandibular fractures.

Materials and Methods: Thirty patients with isolated anterior mandibular fractures were randomly divided into 2 equal groups. ORIF was accomplished in the study group using single 3D miniplates and in the control group using two conventional miniplates. All patients were radiographically evaluated using OPGs and Multislice CT scans (preoperative, immediately and at 3 months postoperative) to assess condylar position regarding (intercondylar distance and intercondylar angle). Clinical parameters evaluated were intraoperative time, occlusion and rigidity of fixation.

Results: Functionally successful osteosynthesis had been achieved in both groups. The 3D miniplates required statistically significant less intraoperative time than the two miniplates. The 3D miniplates recorded less intercondylar distance and higher intercondylar angle than the two miniplates although the difference was statistically insignificant.

Conclusion: The quadrangular geometry of the 3-Dimensional miniplate guarantees comparable fixation rigidity and segment stability and accordingly should be considered an alternative for ORIF of anterior mandibular fractures with the superior advantage of reduced operative time. The 3-Dimensional miniplates provided superior restoration of post-operative condylar position and inter-condylar distance compared to the conventional two miniplates although the difference was statistically insignificant.

Key Words: Anterior mandibular fractures, 3D plates, miniplates, condylar position changes

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INTRODUCTION

Management of jaw fractures represents a considerable challenge. Trauma is a major health jeopardy accompanied by hazardous sequelae. Sufferers of facial injuries have a massive psychological impact[17].

The innovative treatment modalities of mandibular fractures should fulfill; anatomical reduction, stable osteosynthesis and early function[6]. Clinical advantages of miniplates as a treatment modality include ease of adaptability along ideal lines of osteosynthesis, intraoral access, functionally stable and neutralization of developing masticatory forces[30]. It is reported that the mandible is prone to an intricate pattern of forces during mastication. Tension forces on its superior border and compression forces on its inferior border[16, 24]. Moreover, the intense torsional forces resulting from the action of two different groups of muscles; namely the muscles of mastication and the suprahyoid muscles constantly risk the stability of osteosynthesis resulting in complications as improper fracture healing, plate fatigue and breakage, non-union and mal-union[7, 25].

Using the 3D plating system for ORIF of mandibular fracture treatment is somewhat new and was first introduced by Mostafa Farmand in 1992. The Geometry of the 3D plate allows stability in three-dimensions and provides resistance to torsional forces although malleable and low in profile[12]. Such remarkable advantages allowed its use in the management of different types of mandibular fractures like in fixation of angle fractures that showed notable effect regarding postoperative complications in comparison to conventional miniplates[2,26,29]. Besides its use in the treatment of condylar fractures exhibiting superior clinical outcomes compared to miniplates[3,19].

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Anterior mandibular fractures cause tremendous changes in condylar position with flaring of the condyles laterally, thus reversion of the condyles to their prior position and control of mandibular width is mandatory to avoid changes in facial profile, occlusal disharmony and limitation in mouth opening[10].

The purpose of this study was to compare clinically and radiographically between the single 3D miniplate and the conventional two miniplates in the management of anterior mandibular fractures.

PATIENTS AND METHODS

This randomized clinical trial was conducted from December 2015 to October 2019 on patients presented to the outpatient clinic of the Oral and Maxillofacial Surgery Department, Faculty of Dentistry, October 6 University.

Thirty patients suffering from anterior mandibular fractures (symphyseal or parasymphyseal) that were included in this study were randomly divided into 2 equal groups either control or study group using opaque sealed envelopes by a colleague not involved in the study.

The study group enrolled patients in whom (ORIF) was accomplished using single 3D miniplate, while in the control group (ORIF) was accomplished using Champy's two miniplates using the same intraoral approach (sample size was calculated by PS [Power and Sample size]).

Patients Selection Criteria : Inclusion criteria: adults suffering from isolated symphyseal or parasymphyseal fractures, fractures indicated for (ORIF), age range from 18-50 years and free of significant medical illness.

Exclusion criteria: Local criteria: patients with multiple mandibular fractures, associated mid-face fractures, comminuted fractures or with any associated bone pathology.

Systemic criteria: patients with debilitating systemic diseases or bone metabolism disturbances. Patients in this single blinded trial were assessed preoperatively according to the routine protocol of oral and maxillofacial surgery.

Clinical assessment: All patients enrolled in this study were clinically examined in order to assess the site and type of fracture, mobility of fractured segments, dentition status, presence of tooth in the fracture site, injury to inferior alveolar nerve and related numbness, inter- incisal opening, malocclusion and temporomandibular joint associated symptoms.

Before any definitive treatment, care of any lacerated soft tissues and wound debridement for all patients presented with compound fractures. Teeth in fracture lines were managed according to preoperative assessment either by extraction or preservation. Intravenous antibiotics were administered preoperatively at the time of admission and were continued until discharge.

Radiographic assessment: A standard orthopantomogramic view (OPG) was taken for each patient at the time of presentation for assessment of the site and type of the fracture line and detection of any associated dentoalveolar injuries of related teeth and presence of other associated fractures.

Multi-slice axial, coronal, and 3D CT scans of the same machine were performed preoperatively for all patients to assess the preoperative condylar position (intercondylar distance and intercondylar angle) following the protocol introduced by Mariam in 2016[21].

Full detailed written consents were signed by all patients explaining all steps of the surgical intervention and expected complications. This study was performed following the Research Ethics Committee guidelines, Faculty of Dentistry, Cairo University.

Surgical Procedure: Patients were placed in supine position on the operating table and general anesthesia was administrated using nasotracheal intubation then the surgical site was disinfected and patients were draped in the usual manner.

Prior to open reduction, patients were placed into intermaxillary fixation (IMF) with the aid of arch bars or Ivy loops to achieve proper occlusion, all patients of both groups were operated by the same surgical team.

Exposure of the fracture lines was carried out through an intraoral degloving genioplasty incision then the mentalis muscle was incised obliquely and bluntly dissected along its whole length till exposing the inferior border of the mandible. Channel retractors were then applied and reduction was facilitated by applying bone clamps.

In the study group, rigid fixation was done using 3D miniplates with 8 holes (Jeil Medical Corporation, Guro-gu, Seoul, Korea) that were first adapted then positioned across the fracture lines in safe zone so that the superior holes were placed 5mm. beyond the apices of the roots while the inferior ones at the inferior border of the mandible. Eight 2.0 mm monocortical screws were used for plate fixation.

In the control group, rigid fixation was done using two 2.0 mm miniplates, one placed as a superior border plate beyond apices of the roots (Tension zone) and secured with four 2.0 mm monocortical screws while the other one placed at the inferior border (Compression zone) and six 2.0 mm bicortical screws were used for plate fixation.

IMF was then released to check repeatable occlusion, then the oral pack was removed. Layered closure was performed using 3/0 Vicryl sutures first for suspension of the mentalis muscle to its bony attached origin then mucosal closure was performed using 4/0 silk continuous sutures. Application of mental surgical compressive dressing was performed to guard against the development of lower lip sag or witch's chin and removed 7 days postoperatively.

Post-operative Clinical Assessments: Clinical follow-up was scheduled at one week, 1 month and 3 months to assess the stability/derangement of occlusion and mobility of the fractured segments. Other related complications were assessed including wound dehiscence, infection and neurosensory alterations.

Occlusion was assessed along the follow-up periods by evaluating all patients for maximum interincisal opening and maximum intercuspal position and interdigitation to assure the midline centralization and the proper occlusal relationship including molar relation.

Any occlusion disturbance, premature contact or open bite was considered as a malocclusion and was recorded for each group. Any complication was then treated by application of heavy elastics for 2-3 weeks.

Mobility of the fractured segments was assessed along the follow-up periods through bimanual palpation of mandibular segments to check stability.

Assessment was done by applying bending and torsional forces across the fractured segments while detecting movements at the superior and inferior border as well as bucco-lingual splaying.

Surgical intraoperative time was measured from the start of the incision till the last screw to be secured (finalization of osteosynthesis) using the stopwatch of the same digital clock for all patients.

Post-operative Radiographic Evaluation: All patients were radiographically evaluated using both OPGs (Figure 1, 2) and Multi-slice CTs (Figure 3, 4). First evaluation was done the day after operation to inspect (accuracy of osteosynthesis, position of the plates and changes in condylar position). The latter evaluation was done three months later to inspect (Bony union and changes in condylar position).

Methods of assessment: On the most representative axial cut of the CT showing both right and left condylar heads in their largest and defined mediolateral diameter, the medial poles (Condylion Medialis [CoM]) and lateral poles (Condylion Lateralis [CoL]) were marked. These markings allowed for measuring of the intercondylar distance (distance between right CoM and left CoM)[21](Figure 5).

Determination of each condylar axis (line passing through [CoM and CoL]) was performed which is mandatory for measuring the intercondylar angle which results from the intersection of both the right and left condylar axes[21].

Regarding radiographic analysis reliability of CT, the same radiologist was the rater for the measurements (intercondylar distance, intercondylar angle) over the course of the research work. Instrument reliability was achieved by using both the same machine for analysis (Philips Healthcare Imaging System ICAP) and the same software (Philips DICOM Viewer R3. 0L1-SP03).Therefore, reproducible measurements can be obtained by other raters if needed.

STATISTICAL ANALYSIS

Data management and statistical analysis were performed using the Statistical Package for Social Sciences (SPSS) version 19. Numerical data were summarized using means and standard deviations or medians and ranges. Normally distributed numerical variables were compared using independent t test.

Non-normally distributed numeric variables were compared between groups by Mann-Whitney U test. For categorical variables, differences were analyzed with Chi- square test. All p values are two-sided. *P-values ≤0.05* were considered significant.

Fig. 1: Post-operative panoramic radiograph showing 3D plate position

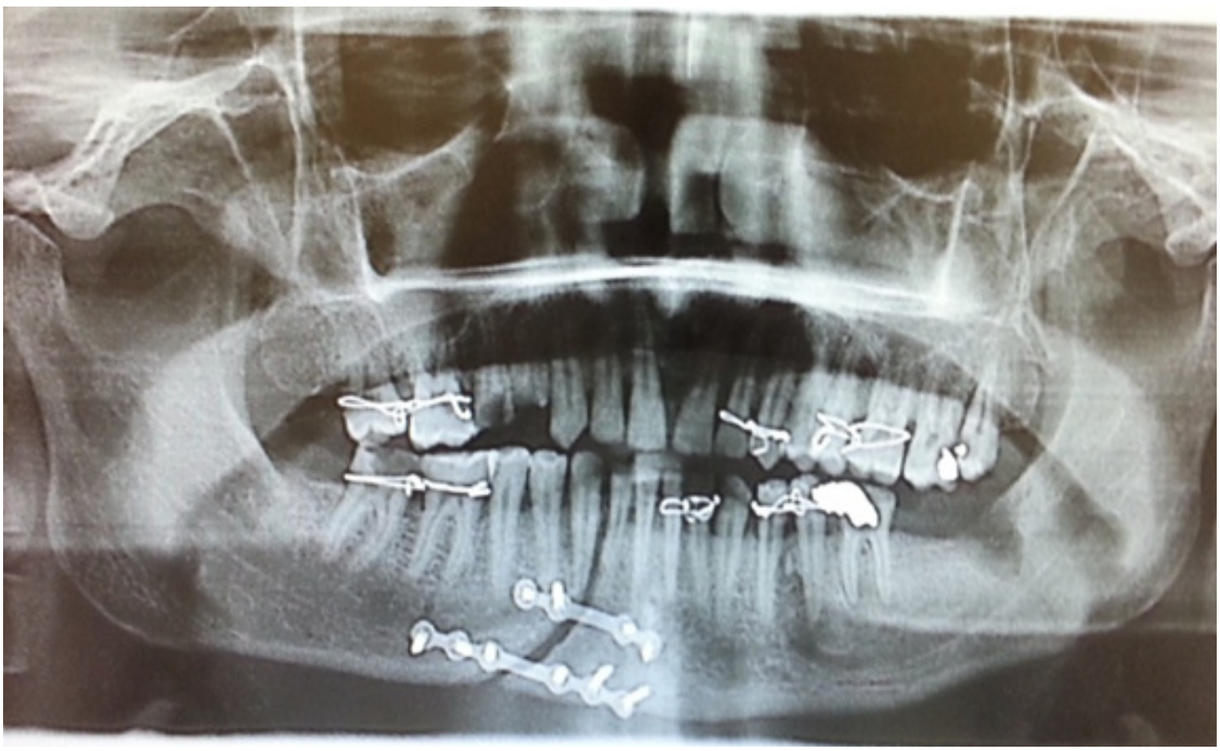

Fig. 2: Post-operative panoramic radiograph showing positions of two miniplates

Fig. 3: Post-operative 3D CT showing 3D plate position

Fig. 4: Post-operative 3D CT showing positions of two miniplates

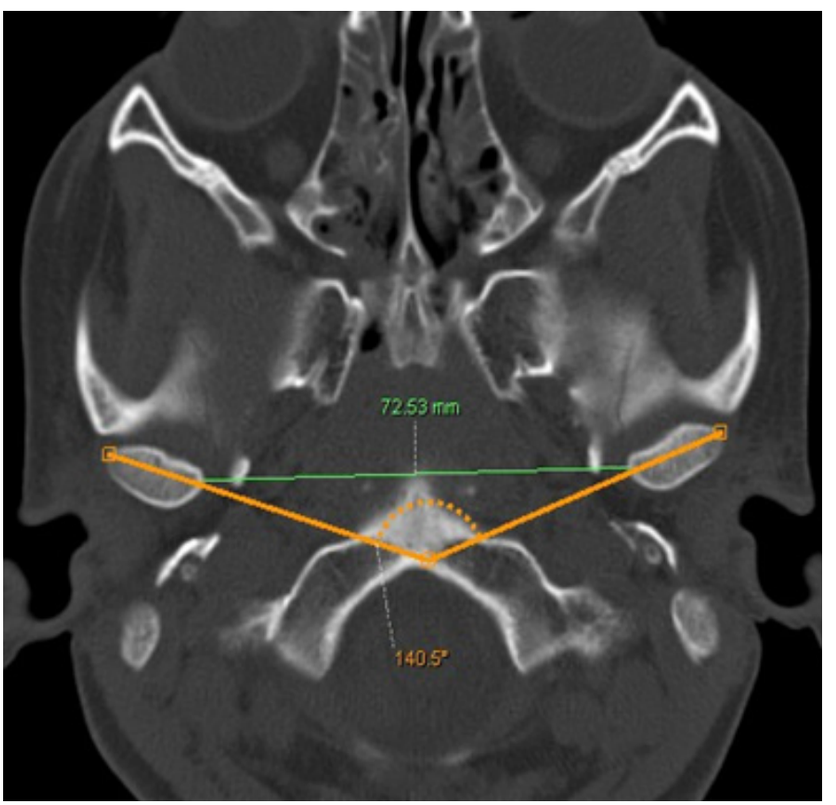

Fig. 5: Measuring of intercondylar distance and intercondylar angle

RESULTS

This study was designed to compare between the single three-dimensional miniplates and the double Champy's conventional miniplates in the treatment of anterior mandibular fractures assessed through radiographic evaluation of changes in postoperative condylar position regarding (intercondylar distance, intercondylar angle).

All 30 patients enrolled completed the study. The study group consisted of 13 males and 2 females, while the control group consisted of 14 males and 1 female. Mean age of patients was 27.47±9.16 years in the study group and 29.60±8.17 years in the control group.

The most common cause for the fractures was road traffic accidents (RTA) and motor vehicle accidents (MVA) (12 cases in study group and 12 cases in control group), while inter-personal violence constituted (1 case in each group) and fall from height was responsible for 4 cases (2 in study group and 2 in control group). Parasymphyseal fractures were most common (12 cases in study group and 14 cases in control group), while symphyseal fractures occurred in (3 cases in study group and 1 case in control group).

The mean treatment interval (days elapsed till patient presentation for treatment) in the study group was 5.56±3.57 days, in comparison to 4.4±1.96 days in the control group.

Two cases of the study group and one case of the control group presented with pre-operative post-traumatic neurosensory deficits in the form of numbness of the lower lip at the time of admission.

None of the patients in both groups suffered from post-operative neurosensory deficits following ORIF of their anterior mandibular fractures. The pre-operative neurosensory deficits that were presented in 2 cases of the study group and 1 case of the control group were completely resolved at the 3-month post-operative interval.

Clinical Evaluation : **A-Intra-operative time:** The 3D miniplates (study group) consumed less operative time (26.33 ± 7.5) than the two miniplates group (34.73 ± 9.42). Independent t test revealed that the difference between the 2 groups was 8.4 ± 3.11 minutes. This difference was statistically significant (*p=0.012*) (Table 1).

B-Occlusion: Any occlusal disturbance in the form of inadequate cuspal interdigitations, premature contacts or open bite was considered as a malocclusion and was recorded for each group. Any occlusal disturbance was then treated by application of heavy elastic guidance for 2-3 weeks. At the one-week post-operative interval, occlusion was found to be slightly disturbed in 2 patients of the study group in comparison to 3 patients in the control group. At the first-month interval, satisfactory occlusion was achieved in all cases. The difference in occlusion was not statistically significant (*p=0.62*) between the two groups (Table 2).

C-Mobility of the fractured segments: Was assessed along the follow-up periods through bimanual palpation of mandibular segments to check stability. Assessment was done by applying bending and torsional forces across the fractured segments while detecting movements at the superior and inferior border as well as bucco-lingual splaying.

None of the cases of both groups showed mobility between the fractured segments immediately post-operatively or at any post-operative follow-up interval (*p=1*) (Table 3).

Radiographic Evaluation of Changes in Condylar Head Position : **A-1-Intercondylar Distance (mm):** The 3D miniplate osteosynthesis study group recorded less intercondylar distance than the two miniplates osteosynthesis control group at both radiographic follow-up intervals (immediately post-operative and after 3 months). Independent t test revealed that the difference between the 2 groups was not statistically significant. The p-value was (*p=0.322*) immediately postoperative and (*p=0.263*) after 3 months (Table 4).

A-2-Percent change in intercondylar Distance: Pre-operatively to 3 months postoperatively, the 3D miniplate osteosynthesis (study group) recorded lower median percent increase in the intercondylar distance compared to the two miniplates osteosynthesis (control group). The overall difference between the 2 groups was not statistically significant (*p=0.917*) where the meanwas0.41 in the study group and 0.61 in the control group, while the standard deviation was 1.44 in the study group and 2.01 in the control group.

B-1-Intercondylar Angle: The3D miniplate osteosynthesis study group recorded higher intercondylar angle than the two miniplates osteosynthesis control group at both radiographic follow-up intervals (immediately post-operative and after 3 months). Independent t test revealed that the difference between the 2 groups was not statistically significant. The *p-value* was (*p=0.333*) immediately postoperative and (*p=0.255*) after 3 months (Table 5).

B-2-Percent change in intercondylar angle: Pre-operatively to 3 months postoperative), the 3D miniplate osteosynthesis study group

recorded greater median percent increase in the intercondylar angle compared to the two miniplates osteosynthesis control group.The Overall difference between the 2 groups was not statistically significant (*p=0.983)* where the mean was 0.37 in the study group and 0.25 in the control group, while the standard deviation was 2.75 in the study group and 2.68 in the control group.

Table 1: Descriptive statistics of intra-operative time (min.) and comparison between groups (independent t test)

Group Statistics				95% Confidence Interval of the Difference					
Group	Mean	Std. Dev	Std. Error	Mean Diff.	Std. Error Diff.	Lower	Upper	t	*P*
Study	26.33	7.50	1.94	-8.40	3.11	-14.78	-2.02	-2.70	.012*
Control	34.73	9.42	2.43						

Significance level $p<0.05$, *significant

Table 2: Descriptive statistics and comparison of occlusion and need of elastics guidance in both groups (Chi square test)

Occlusion					
Study Group			Control Group		
No.	Yes	No	No.	Yes	No
15	2(13.3%)	13(86.7%)	15	3 (20%)	12 (80%)
X^2			0.24		
P			0.62^{ns}		

Significance level $p\leq0.05$, ns=non-significant

Table 3: Descriptive statistics of stability in both groups (Chi square test)

Study Group			Control Group		
Case No.	Immediate Post-operative	3 months later	Case No.	Immediate Post-operative	3 months later
15	100% Stable	100% Stable	15	100% Stable	100% Stable
X^2			0		
P			1^{ns}		

Significance level $p\leq0.05$, ns=non-significant

Table 4: Descriptive statistics of intercondylar distance (mm) and comparison between groups (independent t test)

	Group Statistics						95% Confidence Interval of the Difference			
	Group	Mean	Std. Dev	Std. Error	Mean Diff.	Std. Error Diff	Lower	Upper	t	*P*
Pre-operative	Study	82.97	7.54	1.95	-2.32	2.38	-7.23	2.58	-.98	.338ns
	Control	85.30	5.31	1.37						
Immediate Post-operative	Study	84.42	7.31	1.89	-2.35	2.33	-7.15	2.44	-1.01	.322ns
	Control	86.77	5.29	1.36						
3months	Study	83.26	7.03	1.81	-2.51	2.19	-7.03	2.01	-1.15	.263ns
	Control	85.77	4.78	1.23						

Significance level $p<0.05$, ns=non-significant

Table 5: Descriptive statistics of intercondylar angle (º) and comparison between groups (independent t test)

	Group Statistics						95% Confidence Interval of the Difference			
	Group	Mean	Std. Dev	Std. Error	Mean Diff.	Std. Error Diff	Lower	Upper	t	*P*
Pre-operative	Study	129.18	7.38	1.90	2.97	3.22	-3.65	9.58	.92	.365ns
	Control	126.21	10.04	2.59						
Immediate Post-operative	Study	128.85	7.16	1.85	2.98	3.02	-3.22	9.18	.99	.333ns
	Control	125.87	9.24	2.39						
3months	Study	129.59	7.01	1.81	3.23	2.77	-2.46	8.92	1.16	.255ns
	Control	126.36	8.15	2.10						

Significance level $p<0.05$, ns=non-significant

DISCUSSION

Anterior mandibular fractures are not stable due to individual anatomy, muscular attachments, thickness of bony cortices and frequent exposure to tensile and torsional forces[13]. Few follow-up concatenations in the literature proclaimed 3D miniplate related advantages over conventional miniplates[4].

Symphyseal and parasymphyseal fractures are common mandibular fractures; they represent (30-40%) of all mandibular fractures[5, 20]. The parasymphyseal fractures occurred in (12 cases of the study group) and (14 cases of the control group) while symphyseal ones occurred in (3 cases of the study group) and (1 case of the control group), these outcomes were consistent with literature[1,6,13,21].

The gender predominance was found to be in favor of males than in females. The findings in our study were 13 males in the study group and 14 males in the control group compared to 2 and 1 female in the study and control groups respectively. These results were found to be conformed to those reported by other authors[8,22,37].

In the current study the main cause of anterior mandibular fractures was RTA and MVA (24 cases distributed as 12 in each group) followed by inter-personal violence (2 cases in the study group and 2 cases in the control group) then fall from height (single case for each group), that was found proportional to what introduced by Revati *et al*. in 2019[28].

The outcomes of the present study revealed that 3D miniplate osteosynthesis consumed less operative time than the conventional two miniplates Champy's osteosynthesis showing a statistically significant difference with a mean of (8.4 min.). A study presented by Nilima *et al.*[23] revealed that the average operating time required for the placement of 3D locking plate was approximately (10.34 min.) which was less than that required for placement of Champy's miniplates, these results are nearly consistent with the outcomes of the present study.

The results reported by Revati *et al.*[28] in their comparative study on 70 patients using 3 Dimensional versus standard miniplate in ORIF of anterior mandibular fractures revealed that the mean time required for application of the standard two miniplates was (15.33 min.) compared to the (15.12 min.) required for the application of the single 3D miniplate. Regarding other clinical outcomes differences were statistically insignificant between the two systems.

The simplified adaptation to bone as well as the simultaneous stabilization at both the superior and inferior borders makes the 3D plating system a time-saving alternative to conventional miniplates[15].

Centric Occlusion (CO) is a relationship between the teeth despite position of the condyles. As mandibular fractures lead to changes in CO, accurate reproducing and enduring postoperative condylar position is considered a substantial requisite to achieve a successful reduction and fixation of mandibular fractures. In well dentated patients, the restoration of proper occlusion usually ensures adequate reversion of condyles to their precise centric position. This accurate restoration of condylar position can be verified by clinical as well as radiographic evaluation[9].

Slight occlusal inconsistency in the form of midline shift, open bite or premature contacts occurred post-operatively in 2 cases of the study group using 3D plates compared to 3 cases of the control group using two miniplates indicating that the 3D plating system demonstrated better achievement and stability of occlusion although the difference was statistically insignificant. All occlusal derangements were corrected by application of arch bars and heavy elastics for 2-3 weeks.

Jain *et al.*[15] in his comparative preliminary report of 10 cases of anterior mandibular fractures, compared and evaluated the effectiveness of 2 mm 4 holed 3-dimensional (3D) locking titanium miniplate versus standard miniplates fixation using Champy's technique and concluded that the 3D locking plates provided superior occlusal stability and were economical, easy to adapt, required less operating time. These results were in accordance the results of our study.

Various studies have targeted the topic of geometric accuracy of MSCT (Multi-Slice Computed Tomography) and showed a high precision of this technique[33].

There are only few available studies concerning measurements of the inter-condylar distance and inter-condylar angle mainly in healthy individuals. El-Agroudi demonstrated those and other standard norms in a study of 52 Egyptian adults (27 males and 25 females)[11].

Regarding the inter-condylar distance, El-Agroudi[11] demonstrated that the mean Inter- condylar distance ranged from 90.6mm to 93.4mm in males and 87.7mmin females. In the present study, the mean inter-condylar distance was 83.26mm for the study group and 85.77mm for the control group.

After plating, phenomenal lateral kinking of the fractured segments occurs resulting in increase in the inter-condylar distance[27]. In the present study; the immediate post-operative measurements showed an increase in the inter-condylar distance in both groups. In the study group, the average increase was (1.45mm) compared to (1.47mm) in the control group. Measurements at the 3-month follow-up period revealed a decrease in the inter-

condylar distance in both groups compared to those of the immediate post-operative follow-up interval. However, the study group demonstrated a greater average decrease of about (1.16mm) compared to (1mm) in the control group despite the insignificant statistical difference.

Mariam *et al.*[21] in 2016 evaluated the post-operative changes in inter-condylar distance in 16 patients with anterior mandibular fractures where ORIF was performed using 3D miniplate versus 2.0mm miniplates and demonstrated that the average decrease of inter-condylar distance in the 3D group was (2.72mm) compared to (2.55mm) in the two miniplates group which is consistent with the results of our study.

It has been postulated that this decrease in the inter-condylar distance in both groups at the 3-month follow up interval can be attributed to the compensation of post- operative lateral condylar kinking by the healing process[21,27].

The long axis of the mandibular condyle usually converges backwards. Statistical analysis of various studies showed a wide range of intercondylar angulations ranging from very straight to very acute angulations[34]. The changes in intercondylar angulations had been attributed to condylar torque along its long axis following rigid fixation. An increase in the angulations occurs due to lateral torque and a decrease occurs due to medial one[21].

In the present study, the immediate post-operative measurements of intercondylar angle in both groups showed an initial decrease. The mean decrease in condylar angulation was (0.33º) in the study group and (0.34º) in the control group. At the 3-month follow-up interval, the results showed an increase in the measurements of both groups compared to the immediate post-operative measurements. The mean increase was (0.74º) in the study group compared to (0.49º) in the control group. These results denote superior advantages achieved by the 3D plates compared to the conventional Champey's miniplates in restoring condylar position although the results were statistically insignificant.

In relation to the study group of the present study, the results were consistent with those presented by Mariam *et al*.[21] in which the intercondylar angle showed an average decrease of (1.11º) immediately post-operative which was compensated by an average increase of (0.28º) at the 3-month post-operative interval.

El-Agroudi[11] demonstrated wide ranges of intercondylar axes angulations. The mean Inter- condylar angle was (130.1º) in the total sample, (127.7º) in the male group and (132.6º) in the female group. While in the present study, the mean intercondylar angle was (129.59º) for the study group and (126.36º) for the control group.

The condylar tendency to move towards its pre-injury position in the glenoid fossa after osteosynthesis obtaining good and acceptable occlusion explains the increase over time in the inter-condylar angles[18]. On contrary Hassanein *et al*.[14] concluded that there is a non-significant decrease in intercondylar axes angle after sagittal osteotomies.

The results of our study are consistent with the results achieved by Sehgal *et al.* in 2014[31]. In their comparative study between 3D plates and conventional miniplates regarding ORIF of mandibular fractures. Authors revealed that six patients of the 3-D group and 8 patients of the miniplates group had mildly deranged occlusion on the 7th post-operative day. Moreover, two patients of the 3-D group and 6 patients of the miniplates group required the application of IMF till the end of the 1st month. These results matched those achieved by our study demonstrating superior occlusal restoration and stability provided by the application of the 3D miniplates.

Wusiman *et al.* in 2016[36] performed meta-analysis including randomized controlled trials, controlled clinical trials, and retrospective studies, aiming to compare the clinical outcomes between the standard and the three-dimensional (3D) miniplate fixation in ORIF of mandibular fractures. The meta-analyses showed statistically significant differences in favor of the 3D plates with respect to malocclusion, hardware failure and postoperative trismus and accordingly they concluded that the use of 3D miniplates was superior to the two-miniplate technique in reducing the incidence of postoperative complications during management of mandibular fractures. The results of the present study strongly matches those presented by Wusiman and his co-authors.

Wusiman *et al.* in 2019[35] in his systematic review and meta-analysis comparing the clinical outcomes between the three-dimensional (3D) plate and the standard miniplate fixation systems for the management of mandibular angle fractures revealed that the 3D miniplate caused a lower incidence rate of malunion, malocclusion and hardware failure than the standard miniplate with 8 or 10 holes and postulated that the three-dimensional miniplate was a better fixation system than the standard miniplate technique in reducing postoperative complications in the management of mandibular angle fracture. Again, these results give a great support to the results of our study.

However, the results of our study contrasted those of Sukegawa *et al.* in 2019[32]. In their retrospective clinical study, the authors compared the clinical outcomes of a single three-dimensional (3-D) anatomical plate (13 fractures) versus the two conventional straight miniplates (15 fractures) for ORIF of mandibular subcondylar fractures. Comparative parameters included preoperative conditions of patients and fractures, extent of

postoperative bone healing, and incidence of complications. Other variables included age, sex, fracture site, and follow-up duration. Their results revealed that none of the assessed variables showed significant differences between the two groups ($p < 0.05$). Unfortunately, in the 3-D plate group, re-operation was necessary for non-union owing to plate breakage in one case with a bone defect around the fracture. They concluded that the 3-D plate and the two straight miniplates were equally effective for ORIF of mandibular subcondylar fractures.

CONCLUSION

The 3-Dimensional strut miniplates should be considered as a good successful alternative for internal rigid fixation of anterior mandibular fractures for their ease of adaptation and insertion, while providing the superior advantage of reduced operative time compared to the conventional two Champy's miniplates.

The 3-Dimensional strut miniplates provided superior restoration of post-operative condylar position and inter-condylar distance compared to the conventional two miniplates although the difference was not statistically significant.

RECOMMENDATIONS

It is recommended to have a multi-centered study with larger numbers of cases and linking among these studies would provide conclusive results of statistical significance.

CONFLICT OF INTEREST

There are no conflicts of interests.

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