

EVALUATION OF HERBERT SCREWS & 3D MINIPLATES IN COMPARISON TO DOUBLE MINIPLATES IN FIXATION OF ANTERIOR MANDIBULAR FRACTURES

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ABSTRACT

Objective: Great debate raised on which open reduction and internal fixation treatment method is considered the optimal treatment modality. This study aimed to compare changes in the inter-condylar distance following ORIF using conventional double miniplates, Intra-osseous Herbert screw and 3D miniplates in anterior mandibular fracture.

Patients and methods: 27 patients with 27 anterior mandibular fractures were randomly allocated to three equal groups according to the method of fixation, Group A: Conventional double miniplates, Group B: Intra-osseous Herbert screw and Group C: 3D miniplates. The primary outcome was changes of inter-condylar distances immediately and after three months postoperative. Secondary outcomes were i) occlusion stability and ii) wound infection & dehiscence at two weeks, three months postoperative.

Results: The three groups showed minimal and comparable changes in the inter-condylar distance with no statistical significance difference between the three groups (P value 0.107). there was no statistical significance difference between the three groups after either two weeks or three months (P value 0.782 and 0.354 respectively) regarding the occlusion stability. At the end of follow up period only one patient in group A still suffered wound infection & dehiscence and was scheduled for plate removal with no statistical significance difference between the three groups either two weeks or three months postoperative (P value 0.325 and 0.354 respectively).

Conclusion: The conventional double miniplates, Herbert Intra-osseous screws & 3D miniplates provided minimal changes in the inter-condylar distance with satisfactory occlusion & minimal incidence of wound infection & dehiscence.

KEYWORDS: Anterior mandibular fracture, Osteosynthesis methods, inter-condylar distance changes.

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INTRODUCTION

Mandibular fractures are one of the most common types of traumatic injuries occurring in maxillofacial region. Among these fractures symphysis & parasymphysis account for a wide range of frequency 9% to 57%.¹

Therefore management of these cases require adequate understanding of different treatment modalities available. The past years witnessed significant evolution in treatment options to meet the demands of patient requirements & scientific advances with open reduction & internal fixation (ORIF) remaining one of the best selections for symphysis and parasymphysis fracture.² Numerous methods of ORIF were developed including wire osteosynthesis, compression plate, dynamic compression plate (DCP), eccentric dynamic compression plate (EDCP), reconstruction plate, mono-cortical non-compression miniplates, lag screw, Herbert screw and 3-dimensional (3D) plates.^{3,4,5}

Although each technique has its advantages and disadvantages few of them gained more popularity among surgeons. Champ's miniplates⁶ gained a great deal of acceptance owing to its transoral approach & consistent results with stable occlusion.⁷ A modification of miniplates was described by Farmand and Dupoirieux using three dimensional (3D) quadrangular plates.⁸ The geometry of the plate provide stability and fixation in three dimensions resisting torsional & torque forces though keeping a low profile and malleability.⁹ The unique design of the plate with two linear plates connected by supporting vertical struts resist gap opening at the inferior border by masticatory forces.¹⁰

Herbert screws were originally designed & used for rigid fixation of scaphoid bone fracture.¹¹ The design was modified to be cannulated to allow for more accurate screw placement.¹² Since then, Herbert screws proved to be a successful mean of rigid internal fixation in orthopaedic surgery. The screw design provides compression forces by pitch

difference between the narrow trailing thread and the wide leading thread for improved biomechanical characteristics.¹³ However, the literature lack reports regarding the use of this screw in oral & maxillofacial surgery. Hence, the aim of this study was to evaluate changes in the inter-condylar distance using three ORIF techniques: Conventional double miniplates (Champy technique), Intraosseous "Herbert screw" (Lag technique) and 3D miniplates. In patients with anterior mandibular fracture.

PATIENTS AND METHODS

Study Design This was a randomized clinical trial conducted on 27 patients – a total of 27 fractures- with Symphysis/Parasymphysis fractures. Indicated for open reduction and internal fixation.

Eligibility criteria Inclusion criteria included single line non comminuted symphyseal/Parasymphyseal mandibular fractures, medically free, adult > 18 years, dentate/partially dentate patients, while active infection, metabolic bone diseases, comminution or concomitant sub condylar fracture patients were excluded.

Patients grouping: Patients were reported to the department of Oral & Maxillofacial Surgery Cairo University, Cairo, Egypt. Patients (21 male & 6 female) were allocated to three equal groups according to the method of fixation, 9 in each group. Group A: Conventional double miniplates (Champy technique), Group B: Intraosseous "Herbert screw" with superior border circumdental bridging wiring (Lag technique) and Group C: 3D miniplates.

Preoperative preparation: Trauma survey clearance and emergency care was provided immediately for all patients followed by standard laboratory tests and proper medical consultations. Detailed case history with clinical and radiographic assessment was done and findings were recorded together with written consents. Preoperative clinical parameters included evaluating patients for: 1- Fracture location 2- Dentition status

3- Cause of injury along with the demographic data. Preoperative radiographic parameters included orthopantomograms (OPG) for primary screening and Multi slice computed tomography (MSCT) for assessment of a) Fracture segments displacement and b) Degree of lingual splay.

Surgical procedures : The operation was done under GA. The surgical procedure started with attempting a primary occlusion through arch bar IMF followed by fracture line exposure through transmucosal vestibular incisions. Dissection around the mental nerve was done when needed for ease of retraction and reduction. Curettage and debridement were followed by application of bone compression clamps to secure the reduced segments until proper IMF is achieved. Patients in Group A were fixed using five-hole superior tension zone and inferior compression zone 2.0 mini plates of Normed® Zimmer, starting with the lower plate and with a minimum separation distance of five mm. (Figure1 A) In Group B patients, Kirschner (K) wires were used as a guide for cannulated drilling and assessing the length of the Herbert screw to be placed. Drilling started using 2.7 mm long drill bits extending to the far segment, followed by 3.2 mm drilling of the near segment. The Herbert screw was inserted using a screwdriver compressing the fractured segments together. (Figure1 B) Group

C: 3D titanium plates of Stryker® Leibinger 2.0 mini plates were used for fracture fixation. The plate was oriented in such a way that the vertical arms were parallel to the fracture line and the horizontal connecting arms were perpendicular to it. Diagonally opposite screws were placed first, followed by the remaining screws.(Figure1 C) Layered closure was done after IMF removal and verification of occlusion using resorbable suture material for patients of all groups.

Follow up and outcomes: The primary outcome of this study was to measure the inter-condylar distance change occurred after three months postoperative according to the method originally proposed by Lew and Tay.¹⁴ Intercondylar distances were measured on the DICOM image format using the Mimics* software developed by Materialize NV®, image processing software for 3D design and modeling, on the 3D reconstructed separated mandible after thresholding of axial cuts immediately postoperatively and after three months. (Figure 2) Secondary outcomes were i) occlusion stability-classified as: a). Satisfactory: Complete interdigitation. b). Minimal discrepancy: 1-2 mm gap between opposing first molars. c). Unsatisfactory: > 2 mm gap between opposing first molars and ii) wound infection& dehiscence at two weeks postoperatively and again after three months.

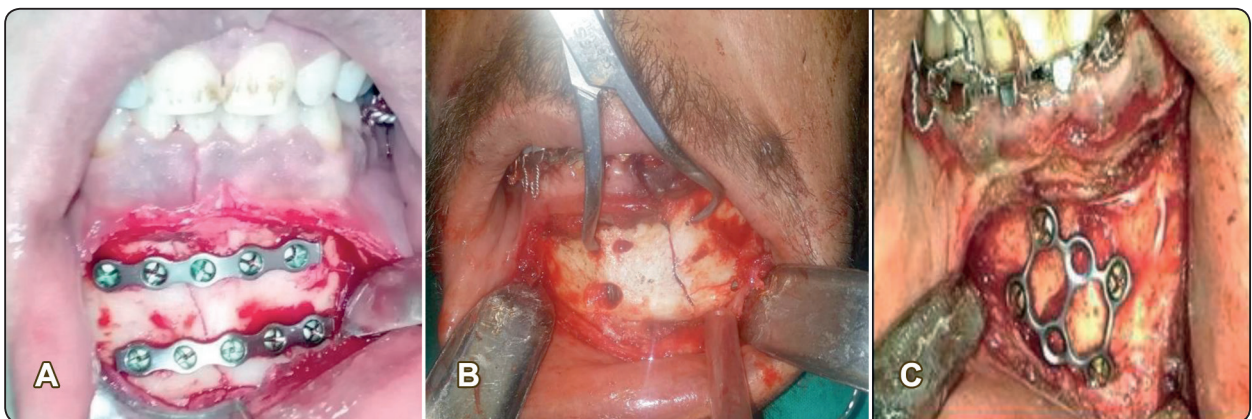


Fig. (1) Showing Intra-operative clinical picture. A: miniplates B: Herbert screw C: 3D miniplates

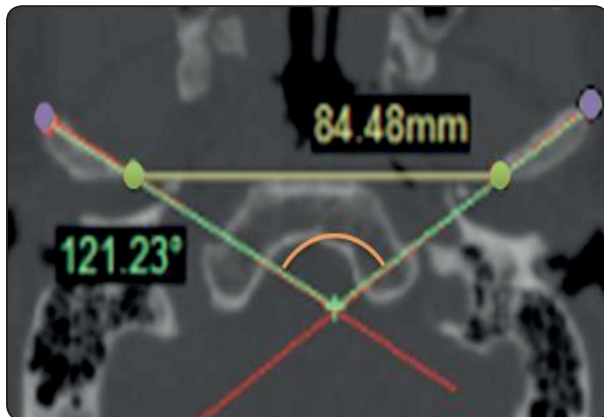


Fig. (2) Mimics® software guided measurement on axial CT image. Purple dot: Condylion lateralis. Green dot: Condylion medialis. Yellow line: intercondylar distance (84.48mm) Orange arc: intercondylar angle (121.23°).

Statistical analysis

Statistical analysis was performed using SPSS (Statistical package for the social sciences- IBM® SPSS® Statistics Version 20 for Windows, IBM Corp., Armonk, NY, USA). Quantitative data was represented as mean \pm standard deviation. Qualitative data was represented as frequency and percentage. One way ANOVA test was used to compare quantitative variables between the groups, and Bonferroni correction to post hoc multiple comparisons. Chi-square test was used to compare qualitative variables between the groups. The results were considered statistically significant if the p value was less than 0.05.

RESULTS

This was a randomized clinical trial study conducted on 27 patients (21males and 6 females) with parasymphysial mandibular fracture. The mean age of the patients was 37.2 ± 9.4 years. The most common cause of the trauma was motor vehicle accidents (59.3%) followed by interpersonal violence (29.6%). The patients were divided into 3 groups according to the method of the fracture fixation. For group A, conventional double miniplates were used. In group B Herbert screw was used while in

group C 3D titanium miniplates were used. The mean age was 39 ± 11.4 years for the group A, 35.7 ± 8.6 years for group B and 36.9 ± 8.7 years for group C. There was no statistical significance difference in age between different groups (P value 0.761). The surgical procedures were uneventful for all patients.

Radiographic results

The three groups showed minimal and comparable changes in the intercondylar distance (0.38 ± 0.18 mm for group A, 0.34 ± 0.2 mm for group B, 0.64 ± 0.5 mm for the group C), and there was no statistical significance difference between the three groups (P value 0.107). (Figure3)

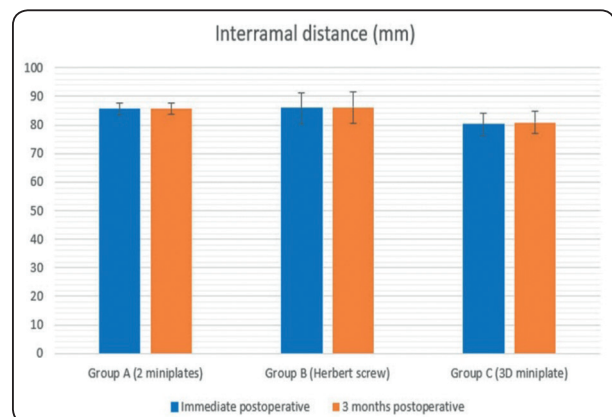


Fig. (3) Bar chart showing changes in inter-condylar distance

Clinical results

In group A, the occlusion was satisfactory for 7 patients (77.8 %), while 2 patients showed minimal displacement (22.2 %) after 2 weeks. After 3 months the occlusion was satisfactory for 8 patients (88.9%), while one patient showed minimal displacement (11.1%). In group B, the occlusion was satisfactory for 8 patients (88.9 %), while one patient showed minimal displacement (11.1%) after 2 weeks. After 3 months the occlusion was satisfactory in all patients. In group C, the occlusion was satisfactory for 7 patients (77.8%), while 2 patient showed minimal displacement (22.2%) after 2 weeks.

After 3 months the occlusion was satisfactory in all patients. All patients with minimal displacement was treated by mechanical spot grinding of high spots to reach optimal occlusion. There was no statistical significance difference between the three groups after either 2 weeks or 3 months (P value 0.782 and 0.354 respectively). (Figure 4 A,B,C)

In group A, dehiscence occurred in 2 patients (22.2 %) after 2 weeks and was treated through continuous irrigation using normal saline, antiseptic mouthwash and keeping good oral hygiene until complete wound healing was achieved after ten days

in one patient while the other one (11.1 %) did not show complete soft tissue healing until the end of the follow up period at three months postoperatively and was scheduled for plate removal. No dehiscence occurred in the group B. In group C, dehiscence occurred in one patient (11.1 %) after 2 weeks and resolved after continuous irrigation using normal saline, antiseptic mouthwash and keeping good oral hygiene. There was no statistical significance difference between the three groups after either 2 weeks or 3 months (P value 0.325 and 0.354 respectively). (Figure 5 A,B,C)

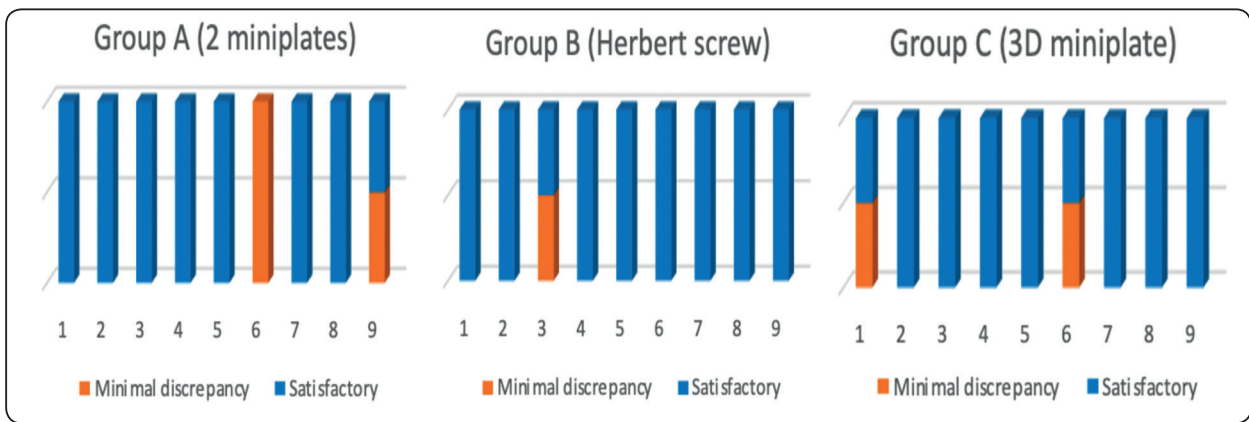


Fig. (4) Diagrams showing changes in occlusion

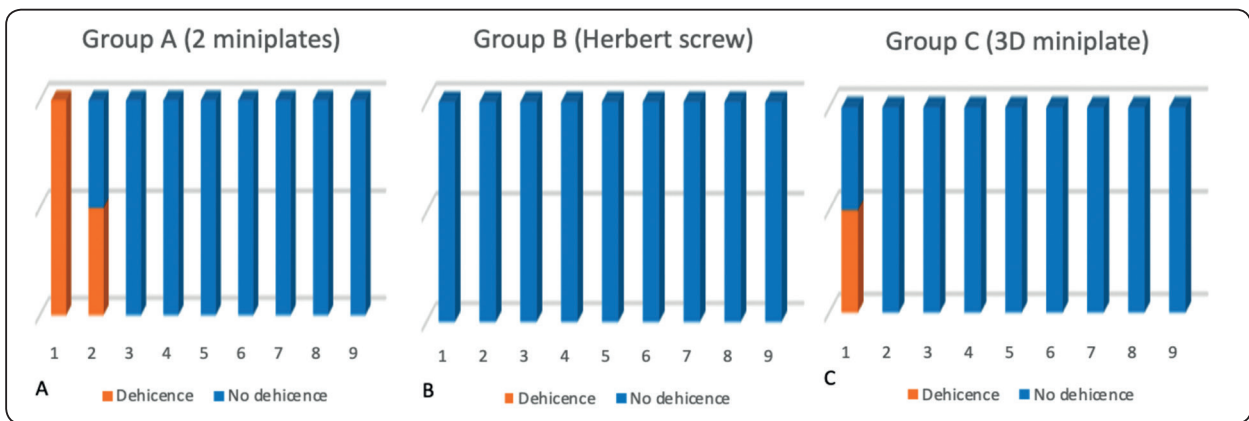


Fig. (5) diagrams showing incidence of dehiscence

DISCUSSION

Managing mandibular fractures is one of the challenging & continuously developing fields of oral & maxillofacial surgery. The Literature is full with studies highlighting different fixation methods maintaining stability at the fracture site, and permitting a prompt return to function with particular care to re-establish the occlusion.¹⁵ A challenge is encountered to achieve adequate stability in the anterior mandible resulting from excessive torsional stresses present at this area. Another difficulty is faced during adaptation of the hardware owing to the parabolic shape & contour of the mandible at this area.¹⁶ Many surgeons consider Chimp's principles with miniplates osteosynthesis as the mainstay for fixation of mandibular fractures due to many advantages offered by this method.^{17,18} With the continuing revolution in fixation methods and improvements in biomechanics other fixation techniques gained more popularity. The current study aimed to evaluate the efficacy of Herbert screws & 3D plates in comparison to miniplates for fixation of anterior mandibular fractures.

The analysis of the demographic data for patients randomly nominated in current study according to the inclusion and exclusion criteria revealed a mean cases age to be 37.2 ± 9.4 years, ranging from 24 to 51 years, these results match that of the other.^{19,20} *El-Mahallawy et al.*²¹ stated a mean age of 29.0 ± 9.74 years in their study evaluating Herbert Bone Screw for mandibular fractures treatment. Another study by *Kumar et al.*²² reported mean age of 33.9 in their study comparing 3D plates to conventional miniplates in fixation of parasymphiseal fractures. It is believed that these results are due the fact that younger adults present a large mass of the population & are more involved in activities.

Regarding the male to female distribution the current study had 21 male & 6 female patients with ration 3.5:1. This male predominance resembles that reported by *El Nakeeb et al.*²³ in their study comparing between 3D plates & conventional miniplates in fixation of fracture anterior mandible. The lower female prevalence reported in the current

study coincide with that documented in other studies,^{24,25} and is thought to be attributed to the fact that males get involved in physical activities & violence at a higher rate than females.

The most common cause of mandibular fracture in the present study was road traffic accidents representing (59.3 %) followed by interpersonal violence (29.6 %). This is in accordance with the literature studies conducted by *Gabrielli et al.*,²⁶ *Bormann et al.*²⁷ and *van den Bergh et al.*¹

In the current study the inter-condylar distance was measured immediately after surgery & at the end of the follow up period. Changes in the linear measurements were used to detect the amount of displacement and lingual flaring produce by function on a long term follow up. The recorded changes were minimal & similar in the three groups without statistically significance difference between them, the values were (0.38 ± 0.18 mm for group A, 0.34 ± 0.2 mm for group B, 0.64 ± 0.5 mm for the group C). These results show that the examined fixation methods provide adequate fixation and stability without significant change of the lingual splay. At the end of the follow up period none of the patients showed any signs of non-union, nor was there any radiographic evidence of plate fracture or screws loosening in any of the patients in either group. This is consistent with the results reported by *Vineeth, K. et al.*²⁸ *Agrawal et al.*²⁹ and *El Nakeeb et al.*²³

Evaluation of the occlusion showed five patients in the current study had minimal occlusal discrepancy after two weeks (group A two patients 22.2 %, group B one patient 11.1 % & group C two patients 22.2 %) without statistically significance difference between the three groups. At the end of the follow up period, three months postoperatively, only one patient from group A still had minimal displacement and required mechanical spot grinding of high spots to reach optimal occlusion. The other groups (B & C) all patients showed satisfactory occlusion. These results are in accordance with the literature as reported by *Mittal et al.*²⁹, *Agrawal et al.*³⁰, *El Nakeeb et al.*²³ *Kotrashetti & Singh*³¹ and *El-Mahallawy et al.*²¹

The incidences of wound dehiscence recorded in the present study was two patients in group A (22.2 %) and one patient in group C (11.1) without statistically significance difference between the three groups. However, these patients showed uneventful healing with secondary intention after proper management except for one patient from group A that was scheduled for plate removal at the end of the follow up period. Similar incidences of wound dehiscence was reported by *Guimond et al.*³² and *Vineeth, K. et al.*²⁸

In the present study the evaluated methods of ORIF provided comparable & satisfactory results in terms of fixation & stabilization of anterior mandibular fractures. However, each technique has its advantages and limitations when compared to the established Champy's miniplates. Herbert screws were found to be highly technique sensitive requiring high surgical skills. Nevertheless, they scored over the other techniques in providing compression fixation, having low cost, requiring fewer instruments & less hardware with better wound healing outcomes. On the other hand, 3D miniplates advantages over conventional miniplates were simplicity, malleability ease of application and adaptation to the bone with simultaneous stabilization at both superior and inferior borders. Though, when the fracture line was oblique or in the vicinity of the mental foramen they were found to be difficult to adapt showing higher probabilities for tooth-root damage and unintentional traction of the mental nerve. Finally the selection of fixation method depends on the exact indication of each case and the experience & preference of the operator.

CONCLUSION

The current study showed that the three fixation methods could be used as good, comparable & alternative methods for each other with no statistical prevalence results of any method regarding intercondylar distance, satisfactory occlusion, minimal incidence of wound infection & dehiscence. Further research with larger sample size is recommended

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