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SINGLE 2.3 RECONSTRUCTION PLATE VERSUS TWO MINIPLATES IN THE TREATMENT OF MANDIBULAR FRACTURES (RANDOMIZED CLINICAL TRIAL)

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ABSTRACT

INTRODUCTION: The foremost maxillofacial fractures, following nasal fractures, are mandibular fractures. Several studies were carried out to improve the techniques used, shorten immobilization period, and improve fixation. One of these modalities is utilization of rigid fixation with a low-profile reconstructing plate.
OBJECTIVES: This research is done to compare clinical in addition to radiological results of a low-profile reconstruction plate with two miniplates.
MATERIALS AND METHODS: 7 patients within each group complaining of recent anterior mandibular fracture (AMF). Group A received treatment with a low-profile reconstruction plate, while Group B received treatment with two miniplates. Follow-up was performed after 24 hours, and one, four, six, and twelve weeks clinically. In addition, a radiographic examination was carried out immediately postoperative and twelve weeks after to evaluate along fracture line the average bone density.
RESULT: All patients reported statistically significant reduction in pain levels throughout the study ($p<0.001$). All individuals demonstrated improvement in maximum mouth opening during the examination; group A ($P=0.002$), while group B ($p<0.001$). Occlusion was normal in both groups. Nonetheless, a single patient of group A showed postoperative wound infection, and there were no wound infections in group B. By comparing postoperative 12 weeks to immediate values, average bone density has risen tremendously. But besides this, group A ($p<0.001$) had a higher mean bone density than group B ($p=0.004$).
CONCLUSION: A low-profile non-locking reconstruction plate produced slightly better results than two miniplates, and equivalent results to a locking low-profile reconstructing plate.

KEYWORDS: Mandibular fracture, Miniplate, Single low-profile reconstruction plate.

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INTRODUCTION

Maxillofacial surgeons have always had a difficult time dealing with maxillofacial trauma. As a result, numerous studies are frequently conducted to improve on established techniques and materials used over time (1). Uninterrrupted recovery, and instant rehabilitation of performance and form with no InterMaxillary Fixation (IMF) period are the ambitious goals in managing mandibular fractures according to Swiss Association for Study of Internal Fixation (AO/ASIF) (1-3).

Through the principles of Champy et al., (3) miniplate fixation has grown in popularity over the years. Miniplates, however, under forces of function may cause torsional movements due to their small size, and reduced rigidity, resulting in infection, non-union, or both (5). Because of the reduced stability of miniplate fixation, a reduced function is recommended following fracture fixation. Some surgeons even recommend IMF for 1-2 weeks (6).

In 2003, a single reconstruction plate fixed close to inferior mandibular margin was introduced by AO/ASIF to overcome the disadvantages of using miniplates, for AMF treatment (5). Yet, in 2010, a low-profile, high-mechanical-strength bone plate restoration system was introduced to treat severely atrophied, and infected mandibles and extremely displaced, and shattered fractures (7, 8).

The thickness of a standard miniplate is 1.0mm, whereas the thickness of a reconstruction bone plate ranges from 1.5 mm to 3.0 mm (9). Besides that, one low-profile reconstruction plate near the mandible's inferior border appeared to be obviating the usage of a second plate as it is capable of resisting tension and compressive forces (1, 10).

According to studies, 1.5mm load-bearing hardware is stronger and can withstand higher mechanical loads than 1.0mm load-sharing hardware (9). Therefore, the objective of this research was to compare a single low-profile reconstruction plate fixation to conventional miniplates fixation of fractures in symphyseal and parasymphyseal regions.

MATERIALS AND METHODS

A one-to-one allocation ratio a prospective randomized controlled clinical trial was carried out after ethical approval from the Alexandria University Faculty of Dentistry's Research Ethics Committee.

Sample size estimation

Sample size was estimated based on assuming 5% alpha error and 80% study power. Sadhwani and Anchlia (10) reported postoperative complications in 40% (6/15) of the patients after using 2mm miniplates. Ghanem et al., (11) reported no post-operative complications when 2.3mm reconstruction plates were used. Based on comparison of proportions, sample size was calculated (12) to be 6 per group and this will be increased to 7 to make up for cases lost to follow-up. The total sample size= number of groups × number per group= 2 X 7= 14.

Patients

This study included fourteen patients from the Alexandria University Teaching Hospital's Emergency Department who had anterior mandibular fractures. Prior to the procedure, all patients signed an informed consent form at Alexandria University's Faculty of Dentistry's Oral and Maxillofacial Surgery Department.

The patients were selected following these bases:

Inclusion criteria

Patients with a recent, uninfected anterior mandibular fracture, Adults aged 20-40 years old with no gender preference who agreed to attend follow-up visits for a minimum of 3 months after surgery, and Fracture requiring open reduction and internal fixation.

Exclusion criteria

patients contradict the operation as they are systemically compromised, infection at the fracture line, fracture due to pathological lesions, and an old trauma fracture.

Using a computer-based site (www.randomizer.org), patients were randomly assigned to one of two groups, each with seven patients with group A receiving a single low-profile reconstruction plate and group B receiving two conventional miniplates.

Using a computer-based site, patients were randomly assigned to one of two groups, each with seven patients

Materials (Figure 1)

The reconstruction 2.3mm low-profile plate is a heavier, and of more thickness in comparison to standard miniplates. To precise contouring to mandible, it comes in a variety of lengths, and can be adjusted in 3D. Is assumed to provide effective force neutralization when stabilized with minimum of three screws on each side of fracture line. The plate is made of pure titanium and has a 1.5mm thickness, which allows for more metal volume inside the plate and a wider plate. Bi-cortical screws used to secure the plate to buccal cortex along mandible's lower border. The screws are made of titanium alloy and have a diameter of 2.3mm and a length of 10mm (Manufactured by Bio Materials Korea Osteosynthesis: Seoul, Korea. www.biomk.com).

The standard miniplate made of pure titanium and has a thickness of 1.0mm. The screws are mono-cortical, created from titanium alloy, and measures 2.0mm in diameter and 7.0mm in length. A 4-hole plate with 4 mono cortical screws is used as a minimum. To treat the fracture in the anterior mandible without any compression or IMF/MMF, two plates are used, the first plate subapical, and in addition a second plate along mandible's inferior border (Manufactured by Stema Medizintechnik GmbH: Stockach, Germany. www.stema-medizintechnik.de).

Methods

Pre-operative assessment and examinations

The patients' full medical histories were obtained. A thorough clinical, intraoral, and extraoral examination was performed to look for swelling, ecchymosis, bleeding, step deformity, soft tissue laceration, hematoma formation, occlusal disturbances, and mandibular deviation when opening and closing the mouth. Furthermore, palpation is used to detect any step deformity, tenderness, segmental mobility, and changes in bone contour.

A pre-operative computerized tomography (CT) scan was done to evaluate fracture line extension, degree of displacement, and involvement of vital structures at the fracture site (Figure 2A, 2B).

Surgical phase

To prevent postoperative infection, Cefotaxime 1 gm/12 hours (Cefotax, E.I.P.I.C.O, Egypt) was prescribed pre-operatively as prophylactic antibiotics. During the procedure, all patients were given general anesthesia and nasal intubation. To prepare the surgical site, sterile towels and swabs with povidone-iodine solution (Betadine 7.5 percent; Purdue Products L.P) were used.

The fracture line was exposed and manually reduced using an intra-oral vestibular incision after Maxillo-Mandibular Fixation (MMF), holding the bone segments in place and visually evaluating the reduction by aligning the buccal cortex and inferior border.

For group A, securing a single 2.3mm reconstruction plate on mandible's inferior border (Figure 3A). For group B, conventional two miniplates based on Champy's osteosynthesis lines were used (Figure 3B). Utilizing vicryl 3/0 suture material to stitch up the surgical wound (Johnson & Johnson Int. European Logistics Centre, Belgium).

Post-operative phase

All patients were given intravenous cefotaxime 1 gm/12 hours on the first day, followed by Amoxicillin + clavulanate 1 gm (Augmentin 1gm: GlaxoSmithKline, UK) twice daily for the next 5 days. In addition to Metronidazole 500mg (Flagyl 500mg: GlaxoSmithKline, UK) every eight hours for 5 days, α-chemo-trypsin (Leurquin France, packed by Amoun pharmaceutical CO.S.A. E-Egypt) ampoules as anti-edematous once daily for 5 days. Furthermore, Diclofenac potassium 50mg (Cataflam 50mg: Novartis-Switzerland) every eight hours for 5 days and Chlorhexidine (Hexitol 125mg/100ml, concentration 0.125%: Arabic drug company, ADCO) antiseptic mouth wash. For one month, patients were advised to practice extremely cautious good oral hygiene, and consume only soft foods.

Follow up phase

For analyzing pain a 10-point Visual Analogue Scale (VAS) was used. A scale of zero to ten (0-1= None, 2-4= Mild, 5-7= Moderate, 8-10= Severe) utilized to ask patients to rate any post-surgery pain and discomfort after 24 hours, one, and four weeks (13). By the help of millimeter ruler maximal inter-incisal distance was assessed after 24 hours, one week, four weeks, six weeks, and twelve weeks (14). Centric occlusion is checked, and signs of any occlusal discrepancies as open bite or abnormal teeth contact after 24 hours, and one, four, six, and twelve weeks, are noted (15). Through follow-up period; plate exposure, wound dehiscence, and minimum signs of wound infection are examined (16).

For analyzing average bone density along line of fracture; an immediate postoperative CBCT-scan was performed, and compared with another CBCT-scan done 12 weeks later (Figure 4A, 4B). The on-demand software (OnDemand 3D APP-DBM, Cybermed, Seoul, South Korea) was used to calculate bone mineral density in Hounsfield Units (HU). Six measurements were taken along the fracture line, and the mean was measured for each patient (17, 18).

Statistical analysis

Usage of IBM SPSS for Windows (Version 23.0) and significance was set at p value <0.05 statistical analysis was performed. Normality was checked for all variables using descriptive statistics, plots (boxplot and histogram), and normality tests. All quantitative variables showed normal distribution, so means and standard deviation (SD) were calculated and parametric tests were used. Frequencies and percentages were calculated for qualitative variables. The two study groups were compared using t-test for quantitative variables, Fisher exact and chi-square with Monte Carlo correction for qualitative nominal variables, and Mann-Whitney test for qualitative ordinal variables. Comparisons of different timepoints *within* each group were done using paired t-test and repeated measured ANOVA for quantitative variables, McNemar test for qualitative nominal variables, and Friedman for qualitative ordinal variables. Post-hoc pairwise comparisons were done in case of significant results for repeated measures ANOVA or Friedman tests using Bonferroni adjusted significance levels.

Figure (1): Reconstruction low-profile 2.3mm bone plate and miniplate.

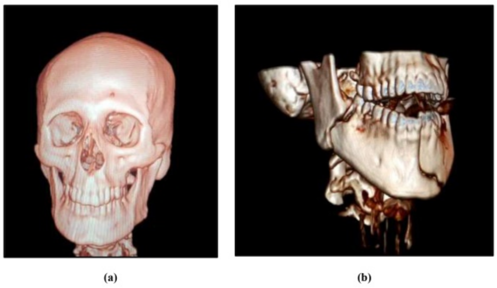

Figure (2): Preoperative CT-scan (a: group A, b: group B).

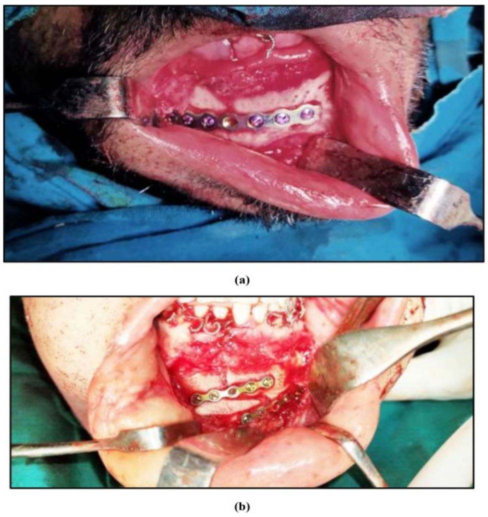

Figure (3): Fixation of fracture line (a: a single 2.3mm low-profile reconstruction plate, b: two conventional miniplates).

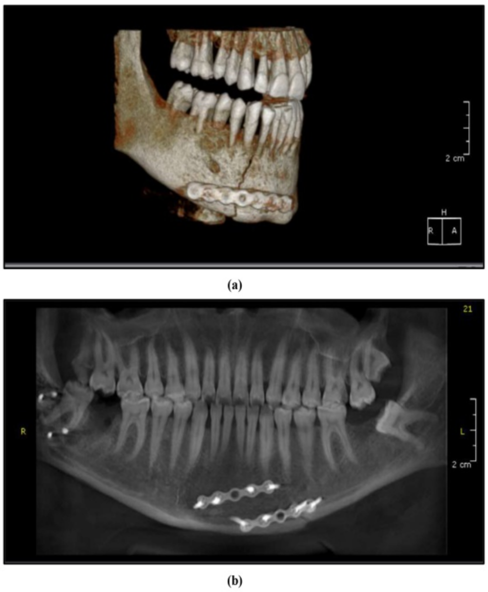

Figure 4: Postoperative CBCT-scan (a: a single 2.3mm low-profile reconstruction plate, b: two conventional miniplates).

Figure (5): Mouth opening in the two study groups at different time points.

RESULTS

Group A (study group) seven patients received a single low-profile reconstruction plate, while group B (control group) seven patients received conventional two miniplates. The age ranged from (20-40) years with a mean age of 32.12 ± 7.59 years in group A (study group), while 29.62 ± 5.18 years in group B (control group) and thus there was no statistical variability between the two groups. The population sample did not include a significantly higher percentage of males in comparison to females in both groups (Table 1).

Throughout the study, only 3 patients in group A and 2 in group B were presented with isolated anterior mandible fracture. On the other hand, 4 patients in group A and 5 in B suffered of other associated fractures. Furthermore, there was no significant variation in terms of traumatization mode between groups or within each group.

Clincal Evaluation

All of the cases studied were followed for 12 weeks after surgery. Statistically significant pain reduction over the course of the study was reported with all patients using the Visual Analogue Scale (VAS). The p value<0.001 in both groups; showing no statistical variation.

According to the ANOVA test for repeated measures, the millimeter ruler used to measure maximal inter-incisal mouth opening revealed that all cases improved statistically significantly over the duration of the investigation; in group A P = 0.002, while in B p<0.001 (Figure 5). However, inter-group comparison using the T-test revealed a statistically insignificant difference at each follow-up period (p>0.005).

Occlusal examination revealed that all of the patients' occlusal and intercuspal relations were normal. After the first week of surgery, a single patient developed postoperative wound infection in group A, and after antibiotic course and appropriate wound care it was treated. Nonetheless, wound healed by secondary intention. However, in none of patients in group B showed signs of wound infection.

Radiographic Evaluation

The immediate mean post-operative bone density of the seven patients in Group A was 537.77 ± 165.81 HU, while the mean bone density 12 weeks later postoperatively was 970.92 ± 212.59. While, in Group B, the mean immediate post-operative bone density was 534.15 ± 114.00, whereas the mean post-operative bone density was 840.98 ± 201.36 after 12 weeks.

In terms of immediate postoperative mean bone density, there was no statistical variation in both groups (p=0.96). Furthermore, 12 weeks later, there was no variation statistically in postoperative bone density between the groups (p=0.23). Nevertheless, when comparing immediate postoperative and 12 weeks postoperative bone density within each group; p<0.001 in group A while p=0.004 in B which mean that mean bone density increased extremly. Despite this, group A had a greater mean bone density than group B (Figure 4A, 4B and Table 2).

Table (1): Baseline characteristics of the two study groups.

Varia bles		tudy (n=7)	ontr ol (n= 7)	va lu e
ge	ean ± SD	2.12 ± 7.59	9.6 2 ± 5.1 8	.4 5 a
end er: N (%)	ale	(71. 4%)	(57. 1%)	.0 0 b
	em ale	(28. 6%)	(42. 9%)	
OT: N (%)	lleg ed ass ault	(0%)	(42. 9%)	MC = 0. 12
	all do wn	(14. 3%)	(0%)	
	all fro m hei ght	(0%)	(14. 3%)	
	TA	(85. 7%)	(42. 9%)	

a: T-test, **b:** Fisher exact tests were used.

Table (2): Bone density at the fracture line in the two study groups

	tud y	**ontr ol**	**test**
	± SD	**Mean**	**val ue**
mmedi ate	37. 77 ± 165 .81	34.1 5 ± 114. 00	.96
month s	70. 92 ± 212 .59	40.9 8 ± 201. 36	.23
aired t-test value	**.00 1***	**.004 ***	

*Statistically significant at p value <0.05

DISCUSSION

Symphyseal and Parasymphyseal fractures accounted for approximately 20% of all reported mandibular fractures (19). They are relatively common and are frequently associated with other indirect fractures, particularly in the sub condylar and angle regions (19). This explains why a higher percentage of patients presented with associated fractures when compared with patients presented with anterior mandible fracture only in both groups.

Naturally, anterior mandibular region is vulnerable. They lack two of the supporting factors found in posterior tooth-bearing mandible fractures; the interdigitation of molar and premolar teeth, as well as counterbalance caused by the lateral masseter and medial pterygoid muscles, which assemble the natural pterygomasseteric sling (20).

In this study, exclusion criteria included patients who were medically compromised, had infection at the fracture line, had fractures caused by a pathological lesion, or had older fractures. This coincides with Hu et al., (21) who excluded patients with comminuted mandibular fractures, or pathological fractures from their study of utilizing a single 2.0mm low-profile reconstruction bone plate against traditional miniplates in treating of linear non-shattered fractures of the mandible's symphysis and parasymphysis field. Further, Tent et al., (22) and Shaik et al., (23) also excluded patients with associated systemic diseases that impeded fracture healing.

Regardless of the location of the fracture, diabetic patients with fractures are at risk of a variety of medical complications following intervention (24). Diabetic and other medically compromised patients can severely hinder wound and bone healing, interrupt healthy vasculature, and increase the risk of infections following fractures (25). Some authors have stated that consequent infections or pre-existing pathological bony lesions (cysts and tumors) may affect the surrounding bone and destroy the mandible, potentially exposing it to further fracture, and therefore delay healing (26-28).

An intraoral incision was used in this study, which has the advantage of avoiding extraoral incisions and scar formation while also being a simple and time-saving surgical technique. It is now widely regarded as the most effective surgical approach for this anatomically accessible area of the anterior mandible (29-32). Its advantages include constant access for inspecting the occlusion, a lower risk of facial nerve damage, and improved esthetics due to the avoidance of extraoral scarring, stated by Nishioka and Van Sickels (29). Ghanem et al., (11) discovered that using an extraoral approach results in scar formation or permanent facial nerve paresthesia, In the study, extraoral techniques were used in 10 patients (31%), while intraoral techniques were used in 22 patients (69%) while treating unsteady diagonal infected fractures with a 2.3mm mandibular osteosynthesis reconstruction bone plate (11). However, given the presence and location of facial lacerations, an extraoral approach was used to extend the primary wound to provide minimal surgical access and expose all fractures for fixation, registered by Kanno et al., (8).

The AO/ASIF technique, which uses a single low-profile reconstruction plate placed near the inferior border and has recently been shown to provide excellent stability, was used in Group A (1, 8, 11, 20, 21). Group B, on the other hand, was treated using Champy's principles of application, with many authors reporting high success rates (3, 34-36).

In both groups, the sample size did not have a significantly higher percentage of males than females. 5 (71.4 %) males to 2 (28.6 %) females in group A, and 4 (57.1 %) males to 3 (42.9%) females in group B. The patient's ranged in age from (20-40) years, with 32.12 ± 7.59 years average in group A and that of group B being 29.62 ± 5.18 years, with age groups similar to those seen in other studies(1, 11, 20). Hu et al., (21) compared a single 2.0mm locking low profile reconstructing bone plate near lower border to two conventional miniplates in cases aged 21-30 years in a similar study. Road accidents were the most common traumatization mode. Increased road traffics, and travelling without using safety precautions, are common findings in developing countries, which may contribute to its high rates followed by aggravated assaults (11).

Postoperative pain levels decreased as measured by the Visual Analogue Scale (VAS). The different pain levels between groups A and B did not differ significantly ($p<0.001$). However, there were tremendous changes within each group through the follow-up time; pain decreased significantly in both groups at 4 weeks and totally vanished at 6 and 12 weeks which is comparable with other studies (11, 21). The patients confirmed at first visit postoperatively low pain level, which receded in second week, recorded by Ghanem et al., (11). According to Hu et al., (21) the variation between groups was not statistically variable while comparing a single 2.0 locking low-profile reconstruction and two conventional miniplates in postoperative pain levels. This could be due to the stiff fixing hardware, which reduces interfragmentary movement and, as a result, the patient's pain and discomfort.

To measure maximal inter-incisal mouth opening, a millimeter ruler was used which revealed that all of the cases improved their maximal mouth opening throughout the study. Considering preoperative mouth opening the average in group A was 25.62 ± 9.80, while in B it was 23.75 ± 6.94. However, 12 weeks after operation; 30.62 ± 7.29 in group A and 26.00 ± 6.39 in group B, indicating no statistical variation between group A with p value=0.002 and group B with p value<0.001. Which is strongly equivalent to Kanno et al., (8) who managed 12 patients with a single low-profile reconstruction plate, and stated that few patients had restricted mouth opening a month after surgery; active physical therapy was provided in the outpatient clinic. After 6 months, all 12 cases had sufficient mouth-opening ranges with stable individual-centric occlusion, and thus no trismus was detected.

There was no malocclusion in either group registered, which is consistent with other findings evaluating occlusion after treating anterior mandibular fracture with either a single low-profile reconstruction plate or traditional two miniplates as documented by Hu et al., (21). There were no complications during the procedure. All patients had good immediate postoperative stability. Intermaxillary fixation was not performed on any of the patients (1).

Only one case in group A showed evidence of local soft tissue infection after week 1 with mild pus discharge, which was traced back to a tooth in fracture line rather than the technique of fixation. It was managed with proper endodontic treatment, daily normal saline irrigation, antiseptic mouth wash, prophylactic antibiotic coverage, and proper oral hygiene maintenance until healing was achieved. This matches with Khalil et al., (20) who managed the treatment of anterior mandibular fractures (AMF) using various fixation methods and stated that 5% of the patients had postoperative wound infection.

While evaluating the technique using a single low-profile reconstruction plate, Parmer et al., (1) found no evidence of facial deformity, malocclusion, trismus, malunion, nonunion, surgical site infection, or osteomyelitis. Furthermore, all patient's bone healing was normal, without any complications like malocclusion, wound infection, or malunion documented by both Ghanem et al., (11) and Kanno et al., (8) in similar studies.

Each subject had one preoperative CT scan and two postoperative CBCT-scans, one immediately after surgery and the other 12 weeks later. The measurements were all taken in Hounsfield Units (HU).

In the immediate postoperative period, the mean bone density was 537.77 ± 165.81 in group A and 534.15 ± 114.00 in group B, which demonstrates no statistical variability between groups (p=0.96). A 12-week postoperative comparison of both groups, the mean bone density was 970.92 ± 212.59 in group A and 840.98 ± 201.36 in group B, indicating an insignificant divergence among the two groups (p=0.23).

In group A, the difference between the immediate and 12 weeks postoperative mean bone density was of statistical discrepancy (p=0.001), moreover, in evaluating difference between immediate and 12 weeks postoperative mean bone density in group B was statistically divergent (p=0.004). Group A had a slightly higher increase in mean bone density 12 weeks after surgery. This could be due to the difference in stability provided by rigid and semi-rigid fixation.

Explaining why group A has a higher HU than group B; this could be due to fracture segment compression and lack of mobility between fracture segments. Rigid fixation is thought to speed up bone healing (36). The use of two non-compression miniplates resulted in an undesirable altitudinous percentage of complications, according to Ellis and Walker (28%) (37). One of the reasons for the limited encouraging analytic sequel of miniplates fixing approaches may be the disturbance of mandibular blood supply caused by reflecting periosteum to stabilize miniplates at the inferior border (11).

Furthermore, Ellis (38) investigated the outcomes of two plate techniques used in anterior mandibular fractures treatment and concluded that utilizing a second bone plate using Champy's technique which marked-up wound dehiscence extent, plate vulnerability, and urgency for plate eradication. It may be reasonable to select one vigorous bone plate to be adjusted near lower margin. Al-Moraissi and Ellis, documented for anterior mandibular fixation with an individual tough plate reduces liability of complexity by 71% when compared to employing miniplates postoperatively (39).

Unstable, shattered, in addition to fractures with infection are not favored to be fixed with miniplates because twisting movements are predicted to be greater in limited rigid miniplates than in reconstruction plates (38). A single low-profile reconstruction plate for mandibular fracture, provided tremendous normalization of anatomy with rigid inner fixation, low disturbance of mandibular blood supply, and reduction of periosteum area being reflected for fixation with plate, registered by Ghanem et al., (11). It also gives excellent steadiness, allowing for significant bone healing (1).

Nonetheless, with no major complications, comparable results were obtained when treating anterior mandibular fractures by conventional miniplate systems involving one plate towards inferior margin plus a second towards superior limit or a single low-profile reconstruction plate placed near the inferior limit with no other plate documented by Hu et al., (21), and Ellis and Edward (38). Yet, critical balance of adequate rigid internal fixation and bony and soft tissue preservation mandatory for effective bone healing (40).

Proper fixation methodology for anterior mandibular fractures is necessary to ensure a successful treatment and early rehabilitation of function. Each methodology has its advantages and disadvantages, so each case must be handled on an individual level based on accurate diagnosis and planning.

The study had some limitations, such as a small number of patients. There have been enough studies on the conventional two miniplates, but not on the single low-profile non-locking reconstruction plate used in anterior mandibular fractures. Registered by Khalifa et al., (20) other limitations include an increased thickness in comparison to miniplates, which increases tactility, a higher incidence of wound dehiscence due to its bulk, and the inability to use postoperative elastic traction to correct minor occlusal discrepancies due to its highly rigid fixation.

The new low-profile reconstruction plate may have resulted in better handling than a conventional thick reconstruction plate by providing more surgical space, the capacity to control equipment easily during surgery, and being nonpalpable.

The plate is adjusted underneath the mandibular neurovascular canal to buccal cortex, and secured along the two sides of fracture with three bi-cortical screws, as a result, neither nerve nor dental injuries were observed recorded by Ghanem et al., (11). Furthermore, even with an intraoral approach, there were no postoperative complications and immediate functional recovery, with almost all patients tolerating a soft diet (18).

The technique is risk-free, allowing for stable, sound bone healing with almost no clinical complications observed over a typical follow-up period, and produced results comparable to the low-profile locking reconstruction plate. In conclusion, the proper selection of the appropriate technique is still debatable.

CONCLUSION

Taking the current study into account, it is concluded that using a single non-locking low-profile reconstruction plate produced comparable results to using a single locking low-profile reconstruction plate in treating anterior mandibular fractures when correlated to miniplates. Furthermore, using single low-profile non-locking reconstruction plates yielded slightly better results than using two conventional miniplates.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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