EGYPTIAN DENTAL JOURNAL
www.eda-egypt.org
VOL. 68, 3117:3128, OCTOBER, 2022
PRINT ISSN 0070-9484 • ONLINE ISSN 2090-2360
ORAL SURGERY
Submit Date : 31-05-2022 • Accept Date : 01-08-2022 • Available online: 1-10-2022 • DOI : 10.21608/edj.2022.142056.2128

MANAGEMENT OF UNFAVORABLE DISPLACED MANDIBULAR ANGLE FRACTURE WITH COMBINED RIGID AND SEMI-RIGID FIXATION USING TRANS-ORAL AND TRANS-BUCCAL APPROACHES. ONE YEAR PROSPECTIVE CLINICAL AND RADIOGRAPHIC STUDY

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ABSTRACT

Purpose: The aim of this prospective study was to evaluate clinical and radiographic outcomes of combined rigid and semi-rigid fixation using trans-oral and trans-buccal approaches in the management of unfavorable displaced mandibular angle fracture with opening mouth immediately postoperatively.

Materials and methods: Thirteen patients (age 16-58 years, 9 males and 4 females) with unfavorable displaced mandibular angle fractures were treated by combined rigid and semi-rigid fixation using trans-oral and trans-buccal approaches. The following clinical parameters were evaluated; pain, infection, maximum mouth opening, neurosensory disturbance, malocclusion/ midline shift, presence of unsightly facial soft tissue scar, muscle trismus, ability to chew hard food, loosening of hardware, and need for alternative treatment. Radiographic evaluation included evaluation of fracture type, any abnormal position of hardware and screws, malunion, displacement if present, and malocclusion using cone-beam computerized tomography (CBCT)that was done preoperatively and at 8weeks postoperative. All parameters were evaluated preoperatively, postoperatively,3 weeks,8 weeks, 6 months, and 12 months later.

Results: Maximum mouth opening preoperatively (8.52mm) significantly increased postoperatively to 30.57mm, then significantly increased at 3, 8 weeks, and 6 months. All cases (13 patients) were detected with pain perioperatively which continued to 3 weeks then significantly decreased at 8 weeks and disappeared after 6 months. Seven cases presented with infection preoperatively which significantly decreased to 2 cases postoperatively and disappeared after 3 weeks. All cases had trismus which significantly decrease postoperatively and disappeared after 6 months. Three cases were detected with neurosensory disturbance postoperatively and disappeared after 6 months. All patients were unable to chew hard food till 8 weeks. No cases were detected with malocclusion/midline shift, malunion, non-union, unsightly facial soft tissue scare, no need for any alternative treatments or loosening of the hardware was detected postoperatively.

Conclusion: Within the limitation of this study, combined rigid and semi-rigid fixation using trans-oral and trans-buccal approaches in the management of unfavorable displaced mandibular angle fracture is an effective treatment modality as it was associated with favorable clinical and radiographic outcomes with reduced complications after one year.

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INTRODUCTION

Mandibular fractures comprise a 70% of maxillofacial fractures.[1] it is commonly occurred in especially young and middle-aged males as a result of violence, assault, traffic accidents, and falls[2]. Mandibular angle fractures presented 26%–35% of all mandibular fractures[3]. Several reasons are responsible for the increased incidence of mandibular angle fracture such as; the abrupt change of the anatomy of the mandible from vertical to horizontal at the angle, the presence of the third molar impacted teeth which weaken this area[4], and biomechanics of angle as a lever area[5] Mandibular angle fracture have increased complication rate after surgery, which may reach 32% and are the most difficult complications to treat.[6]

The unfavorable fracture of the angle is associated with displacement of the fractured segments by the action of masticatory muscles and usually needs open reduction and internal fixation[5]. The treatment is usually complicated by limited intraoral access[7]. The type of surgery required for reduction and fixation of unfavorable mandibular angle fracture is governed by several factors such as the site and type of fracture, amount of displacement, and clinical experience of the surgeon[8]. The treatment of choice of management of mandibular angle fracture should provide perfect reduction of fractured segments, stable fixation, painless mobilization of the jaw, reduction of post-operative complications, and achieving an immediate function[9]. The biomechanical forces at the angle, the presence of third molar at fracture line, the occlusion state, and the limited intraoral access to the fracture site are issues that may cause problem of achieving stable fixation[10]. Various treatment approaches ranged from simple intermaxillary fixation to open reduction and rigid internal fixation to provide immobilization of the bony fragments to facilitate healing[11]. However, the ideal treatment still needs to be determined[8]. Several shapes, sizes, designs and numbers of plates and screws have been used. However, satisfactory results are difficult to achieve due to forces of pterygoid and masseter muscles that can easily displace fractured segments[12]

Several studies reported that transbuccal approach shows fewer complications, superior results and less time consuming than extraoral approach when used for the treatment of mandibular angle fractures. However, it required special instruments and lot of skills[13, 14]. Mehra et al. concluded that isolated mandibular angle fractures can be effectively managed with either intraoral monocortical fixation or extraoral bicortical fixation techniques[15]. Achieving stable internal fixation using a low-profile reconstruction plate system is an effective treatment as it enables immediate functional recovery with results[16].

The non-rigid fixation using miniplates achieve good stability for most isolated fractures including displaced fractures of the angle, symphysis, or body[17, 18]. The fracture fixed with single miniplate had a minimal amount of soft tissue stripping necessary to visualize, reduce, and stabilize the fracture[19]. However, in patients with combined angle and contralateral body/symphysis fractures, or with displaced mandibular angle fracture, a single miniplate cannot resist the increased forces applied on the fracture fragments, with increased risk of segment displacement and rigid fixation is needed[20]. Rigid plates (2.4mm to 2.7mm) are used at the inferior border of the mandible to give rigidity, neutralization of forces and prevent mobility between fragments, consequently it decreases the rate of postoperative complications[10, 21].

Reviewing the literature there is a limited number of studies comparing rigid and nonrigid fixation in treating mandibular fractures[2]. In a recent study Rughubar et al.[19] evaluated post-surgical complications in patients treated with a combination of rigid fixation for anterior fractures and nonrigid fixation for the posterior fractures. They found a similar complications and functional outcomes

in patients with bilateral mandibular fractures treated with a combination of rigid and nonrigid fixation in patients with bilateral mandibular fracture to nonrigid fixation. Furthermore, the use of combination of rigid and nonrigid fixation in management of unfavorable (displaced) unilateral mandibular angle fracture was not sufficiently investigated. Accordingly, the aim of this single arm prospective study was to evaluate clinical and radiographic outcomes of combined rigid and semi-rigid fixation using trans-oral and trans-buccal approaches in the management of unfavorable displaced mandibular angle fracture with opening mouth immediately postoperatively.

PATIENTS AND METHODS

Patient selection

This prospective single arm study was conducted on thirteen patients (age 16-58 years, 9 males and 4 females) with unfavorable displaced mandibular angle fractures who were selected from the outpatient clinic of the Oral and maxillofacial surgical Department, faculty of dentistry, Delta University. The following data were collected after examination of the patients; age, gender, cause of fracture, presence of mandibular third molars, occlusal relation, and presence of complications. Inclusion criteria were; 1) time elapsed from trauma to the surgery not more than 10 days, 2) all cases had an unfavorable mandibular angle fracture with displacement (moderate, and severe) preoperatively, 3) single or combined unilateral mandibular angle fracture resulted from (assault, n=7, road traffic accident, n=5, and fall, n= 1). 4)wisdom tooth at the line of fracture was preserved except if it is loose, fractured root, badly decayed, infected, or prevent proper reduction of bony segments at surgery, in these cases it was removed, 5) All patients received intermaxillary fixation (IMF) that was done preoperatively using arch bars and intermaxillary wiring 6) deranged occlusion preoperatively due to mandibular angle fracture. Patients were excluded if they had one of the following conditions; 1) fractures with multifragmentation; 2) fractures with signs of severe infection, 3) fractures in edentulous patients, 4) concomitant maxillary fractures, and 5) severe injuries leading to life-threatening. The study protocol and objectives were described for all participants before they signed informed consent. The study was reviewed and approved by the ethical committee of the faculty of dentistry and the study was conducted according to principles of ethics stated in the Helsinki Declaration.

PREOPERATIVE PROCEDURES

Preoperative (CBCT) were made for all participants to evaluate the amount of displacement (moderate-severe); moderate displacement was diagnosed if displacement is nearly the width of a single cortex; and severe displacement was diagnosed if displacement is more than 1 cortical width[19]. Moreover, the following conditions were evaluated : the line direction of the fractures, the location of the inferior alveolar canal, and the presence of a tooth in the fracture line (fig.1)

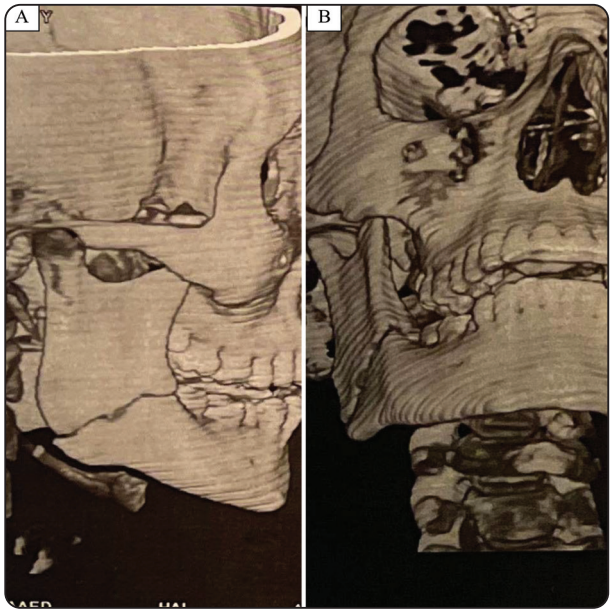

Fig. (1): Preoperative 3D. CBCT shows unfavorable severely, and moderately displaced (A &B in order) mandibular angle fracture with gagging of occlusion.

All patients were administered systemic antibiotics and scheduled for surgery within one week after the initial examination. Mandibular third molars in the line of fracture were extracted if they were loose before reduction and plating[19]. Patients received rigid fixation at the angle of the mandible near the inferior border and nonrigid fixation on the crest of the ridge. Rigid fixation was defined as fixation that prevents interfragmentary motion under function and was achieved by a single plate at the compression zone of the fracture line. Nonrigid fixation is functionally stable but may allow micromovement between the bony fragments and was achieved by a miniplate applied at the tension zone of the fracture line[2]. For all patients, the fracture was reduced guided by the occlusion of the teeth and all patients received intermaxillary fixation (IMF) with arch bars before surgery.

Surgical procedures

The surgery was performed under general anesthesia. Two CC Adrenaline infiltration (1:100.000) was used for hemostasis at the site of the incision, Intra-oral crestal incision that extends about 1cm at the anterior border of the ramus and anteriorly to the mesial surface of the mandibular first molar that allows proper access to surgical site without tension as well proper visualization of fracture line with fractured bony segments. The mucoperiosteum is raised until below the neutral zone. Also, a trans buccal incision was made using stab incision parallel to relaxed skin tension lines of the cheek that is placed over the desired osteosynthesis site, trans buccal trocar and cannula were inserted buccally down to the bone and u-shaped retractors were attached to transbuccal cannula to allow proper retraction of soft tissue and ease of vision of determined drilled sites. Four holes were drilled for 2.3 mm rigid non-compression plate(1.5mm thickness) (STEMA Medizintechnik GmbH, Germany) in the lateral surface of the mandible after proper adaptation of the plate (2 holes on each side of the fracture line) that allow the use of bi-cortical screws of at least 9mm at this site,the hole bed is drilled 1.8mm. The non-compression rigid plate is introduced through the mouth and fixed by the use of bi-cortical screws through trans buccal trocar, then irrigation using saline solution was performed, 4 holes were drilled intraorally (2 on each side of the fracture line), and four holes 2.0 miniplate (1.0mm thickness, STEMA Medizintechnik GmbH, Germany) was selected and adapted properly and passively to operated mandible. The miniplate was placed along the superior crest of the external oblique ridge. Drilling was started at the nearest hole to the fracture line at the proximal part then the same hole was drilled in the distal part. The hole bed is drilled 1.5mm using trans-oral approach, and then mono cortical screws (6mm near the teeth and 7mm away from the teeth) are introduced into its holes and tightened at the end of the procedure. Checking of movement at the fracture site or loosening of hardware was done before suturing of the flap. The intermaxillary fixation (IMF) is released and the mouth was opened immediately after surgery, and the mouth was opened at end of surgery and checking of proper occlusion was made. The stability of fractured bony segments with no movement in it or loosening of hardware was checked. The mouth opening was checked. The immobility of fractured segments was assessed at the end of the operation, then the flap was closed using absorbable sutures (vicryl, 000), and the skin incision was closed by two interrupted sutures using non-absorbable proline (0000) and it was removed 5 days postoperatively (Fig.2)

No drains were placed. Postoperative antibiotic and anti-inflammatory medications were prescribed for 7-10 days (Augmentin 1grame tablet twice daily and ibuprofen 600mgm twice daily as well chlorhexidine-hexitol-mouth wash was prescribed). Immediate postoperative panoramic radiographic images were used to evaluate the adequacy of fracture reduction, and proper position of screws and hardware (Fig.3). After 10 days, physiotherapy was initiated to prevent TMJ ankylosis[10].

Fig. (2): Five days postoperative, patient came to remove facial sutures and minimal scar was present that disappeared totally after 2 months

Fig. (3): Immediate postoperative panoramic radiograph shows proper reduction and alignment of fractured mandibular angle, with proper position of rigid plate and screws near inferior border and mini plate fixation at upper border without affection of teeth or nerve.

Study outcomes

Clinical follow-ups were performed every day in the first week, every week during the first month, 3 weeks, 8weeks, 6 months and 12 months postoperatively[10]. The following clinical parameters were evaluated by the same surgeon preoperatively, postoperatively, 3 weeks, 8weeks, 6 months and 12 months later:

- Pain: (No; score 1, Yes; score 2)
- Infection: is the presence of clinical signs such as swelling, erythema, pain, or purulent discharge[2]. (No; score 1, Yes; score 2)
- Maximum mouth opening: was evaluated using the mandibular mobility index[22]. Interincisal opening/maximal opening was defined as the distance in mm between the edges of the maxillary and mandibular incisors.
- Trismus
- Neurosensory disturbance: presence of facial nerve weakness, or sensory nerve injury[10](No; score 1, Yes; score 2)
- Malocclusion, deviation of midline during opening: the deviation from the normal occlusion. It was assessed using a thin-paper bite test. Patients bite on a thin strip of paper (<1 mm). Deviations of teeth>1mm were considered major, while deviations <1 mm were considered minor[2]. (minor; score 1, major; Score 2) (Fig4)

Fig. (4): Proper occlusion had obtained immediate postoperative after release of intermaxillary fixation.

- Presence of soft-tissue scar/dehiscence of the incision: was defined as a disruption, splitting, or gaping along the natural and opposed surfaces of a wound[2] (No; score 1, Yes; score 2)

- Ability to chew hard food; (No; score 1, Yes; score 2)
- Loosening of hardware: included hardware loosening, hardware breakage, and screw loosening[2] (No; score 1, Yes; score 2)
- The need for alternative treatment. (No; score 1, Yes; score 2)

Radiographic evaluation included evaluation of malunion or un-union, displacement if present, and malocclusion/midline shift using cone-beam computerized tomography (CBCT). (No; score 1, Yes; score 2). Radiographic evaluation was done preoperative ,8 weeks postoperative using (CBCT)(Fig.5)

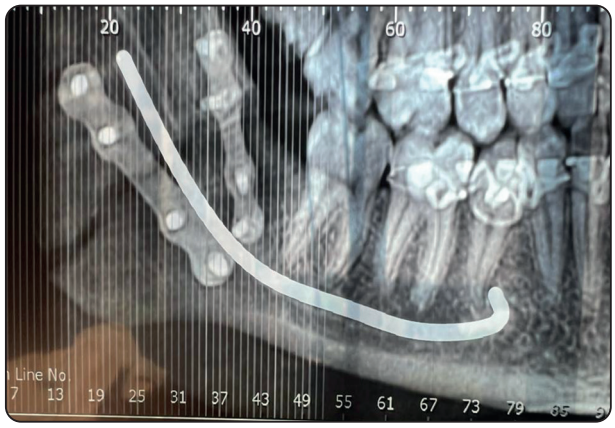

Fig.5: CBCT was done two months postoperative showed properly reduced and fixated mandibular angle using rigid and semi rigid fixation without harm to nerve or teeth as well good bony union.

Statistical analysis

The data normality and distribution was verified by Shapiro wilk test. Parametric data were expressed as the mean±standard deviation, and non-parametric data (Scores) were presented as number and percent. Comparison of maximum mouth opening between time intervals was made by Repeated measures ANOVA followed by paired post hoc t-test. Comparison of all other parameters was made by Cochran's Q test followed by McNamar tests for pair-wise comparisons. Data analysis was performed with SPSS program (SPSS Inc., V. 22, Chicago, IL, USA). P is significant if < 0.05.

RESULTS

All patients attended the regular recall visits without dropouts due to the short evaluation period. Comparison of mean maximal mouth opening (in mm) between observation times is presented in table 1. There was a significant difference in maximum mouth opening between observation time (p<.001). Maximum mouth opening preoperatively (8.52mm) significantly increased post operatively to 30.57mm, then significantly increased after 3 weeks, and 8 weeks. At 8 weeks, 2 cases who had infections suffered from decreased mouth opening (22.5mm) one case had bad oral hygiene and another case had uncontrolled diabetes mellitus. Both cases assumed good mouth opening at 6 months. However, no significant difference in maximum mouth opening between8 weeks, 6 and 12 months was observed.

Comparison of the incidence and frequency of all other clinical and radiographic parameters between observation times is presented in table 2. All cases (13 patients) detected with severe pain preoperatively, and post-operatively (6 cases with moderate pain, 7 cases with severe pain). After 3 weeks, 9 patients were detected with mild pain and 4 patients with moderate pain. After 8 weeks, 11 patients had no pain and 2 patients had severe pain. The pain disappeared after 6 and 12 months. There was a significant difference in pain between observation times (p<.001). The incidence of pain significantly reduced after 8 weeks and no significant difference in pain was noted between 8 weeks, 6 and 12 months.

Seven cases presented with infection preoperatively. Two cases had infections immediate postoperatively. No cases presented with infections after 3 weeks, 6 months and 12 months. At 8 months, 2 patients presented with infection (one was uncontrolled diabetic patient, he was given antibiotics, and referred to physician for glycemic control) and the other case had bad oral hygiene (stressed with antibiotic Augmentin 1gm twice daily for a week. The

infection significantly decreased postoperatively, and at 3 and 8 weeks. However, no significant difference in the incidence of infection between observation 6 months and 12 months was noted. All cases presented with trismus preoperatively. 4 cases had mild trismus postoperatively (muscle relaxant was given intraoperatively by the anesthesiologist (such as succinylcholine). After 3 weeks, 2 cases had mild trismus and 4 cases had moderate trismus. At 8 weeks 2 cases (who had infection) presented with moderate trismus. However, at 6 and 12 months, no cases presented with trismus. Trismus significantly decreased from preoperative to postoperative visits. No significant difference in trismus between postoperative, 3 and 6 weeks was noted. All cases were presented with malocclusion/midline shift preoperatively. No cases were detected with malocclusion postoperatively or in the follow up visits. Malocclusion/midline shift significantly decreased from preoperative to post operative visits. Also significant difference was noted in jaw deviation from midline towards the affected fractured side between preoperative and immediate postoperative records as all cases showed deviation towards midline preoperatively while 4 cases postoperative showed mild shift from midline whom had trismus of jaw muscles, at 3 weeks no shift was noted, as well at 8 weeks ,6 months ,and 12 months

Preoperatively, 13 cases were detected with unfavorable displaced fracture on CBCT (4 had sound wisdom teeth, 6 did not had wisdom teeth, 3 had wisdom teeth that were affected and removed intraoperatively). After 8 weeks no displacement, fracture of the hardware or the screws were detected, no cases were detected with malunion (all had bony union) or un-union in the CBCT images. Also no injury to the inferior alveolar nerves or the teeth from screws were detected in CBCT images. There was a significant reduction in un-union in CBCT images at 8 weeks compared to preoperative situation. Also significant difference was noted in dental occlusion between preoperative and immediate postoperative as all cases showed massive derangement in occlusion preoperatively while all cases had good occlusion postoperatively.

TABLE (1) Comparison of mean maximal mouth opening (in mm) between observation times

	Maximal mouth opening	
	X	SD
Preoperative	8.52a	3.37
Postoperative	30.57b	5.34
3 weeks	37.59c	6.23
8 weeks	41.87d	5.47
6 months	43.00d	4.35
12 months	43.93d	4.71
Repeated ANOVA	<.001*	

p is significant at 5%. Different letters indicate significant difference between each 2-time intervals.

Three cases were detected with neurosensory disturbance preoperatively and postoperatively, for those 3 cases compound vitamin B (B1,6,12) was prescribed for 6 months (neurorubine forte one tablet per day for 3 weeks then one tablet each 3days for 6 months. After 3 and 8 weeks, 2 cases were detected with neurosensory disturbance. No neurosensory disturbance was found at 6 or 12 months. There was a significant difference in the incidence of neurosensory disturbance between observation times. The incidence of neurosensory disturbance significantly decreased at 6 months and no difference was noted between 6 and 12 months. All patients were unable to chew hard food preoperatively, post-operatively and at 3 weeks as all patients were restricted for soft diet, and the patients started to eat moderate and hard foods from 6 weeks. At 8 weeks 11 patients were able to chew hard foods and all patients were able to chew hard

foods at 6 and 12 months. There was a significant difference in the incidence of ability to chew hard food between 3 weeks and 8 weeks. The incidence of ability to chew hard food showed no significant difference between 8 weeks, 6 and 12 months. No cases were detected with presence of unsightly ugly soft tissue facial scares postoperatively or in the follow up visits. No cases were detected to need any alternative treatments postoperatively or in the follow up visits. No cases were detected with loosening of the hardware postoperatively or in the follow up visits.

TABLE (2) Comparison of the incidence and frequency of all other clinical and radiographic parameters between observation times

	Preoperative	Postoperative	3 weeks	8 weeks	6 months	12 months	Cochran's Q test
Pain	13 (100%)a	13 (100%)a	13 (100%)a	2 (15.38%)b	0 (0%)b	0 (0%)b	<.001*
Infection	7 (53.8%)a	2 (15.4%)b	0 (0%)c	2 (15.4%)d	0 (0%)c	0 (0%)c	.002*
Trismus	13 (100%)a	4 (30.76%)b	6 (46.15%)b	2 (15.4%)b	0 (0%)c	0 (0%)c	.001*
Neurosensory disturbance	3 (23%)a	3 (23%)a	2 (15.38%)a	2 (15.38%)a	0 (0%)b	0 (0%)b	.049*
Malocclusion, deviation of jaw midline	13 (100%)a	0 (0%)b	0 (0%)b	0 (0%)b	0 (0%)b	0 (0%)b	.001*
Unsightly ugly facial scar	0 (0%)a	0 (0%)a	0 (0%)a	0 (0%)a	0 (0%)a	0 (0%)a	1.00
Ability to chew hard food	0 (0%)a	0 (0%)a	0 (0%)a	11 (84.6%)b	13 (100%)b	13 (100%)b	<.001*
Loosening of hardware	-	0 (0%)a	0 (0%)a	0 (0%)a	0 (0%)a	0 (0%)a	1.00
Need alternative treatment	-	0 (0%)a	0 (0%)a	0 (0%)a	0 (0%)a	0 (0%)a	1.00
Presence of malunion on CBCT	13 (100%)a	-	-	0 (0%)b	-	-	.001*

p is significant at 5%. Different letters indicate significant difference between each 2-time intervals.

DISCUSSION

The aim of management of mandibular fracture is the restoration of occlusion, and healing of fractured bone[10]. Proper fixation with undisturbed healing is mandatory to avoid infection, malocclusion, or non-union[23,24]. Several confounding factors can control the choice of proper treatment approach as the location of the fracture, the type of fracture, the degree of displacement of fractured bones, the existing teeth, aesthetic demands, and experience[8]. The use of the rigid reconstruction plates with traditional extra-oral approach provides effective fixation, however, it has several drawbacks as; resultant extraoral scar, injury to the mandibular branch of facial nerve[25], bicortical screws causes sensory disturbances of inferior alveolar nerve, postoperative malocclusion may occur due to problems in bending and adapting the rigid compression plate[26]. Studies showed increased surgical time with the transbuccal approach when compared to the transoral approach[27, 28]

In contrast, the transoral approach avoid extra-oral scar, provide more esthetics and gained more patient acceptance[29]. Moreover, it allows early removal of intermaxillary fixation, early return to function, provides stable reduction, reduce the risk of displacement postoperatively, decrease hospital stay, and provide rapid healing[30, 31]. In addition, it provided shorter surgery, reduced cost of the hardware, and allow patient to return easily to function[32]. Champy[33] used miniplates on superior border of the mandible to obtain ease of adaptation, optimal fixation, reduce the risk of facial nerve injury and formation scar. Moreover, it allows confirmation of occlusion during surgery, and less palpable as it is thinner. Moreover, its removal is easy[31]. It was reported that single miniplate had lower complications [34] than double miniplates fixation[35]for mandibular angle fractures[7]. Several studies reported high success and reduced complications with superior border plates for isolated mandibular angle fractures[4, 15, 36]. In addition, Ellis[36] reported that single superior border miniplate was easy to use and had reduced complications, provide sufficient stability that allow healing of unilateral angle fracture[36, 37]. Taking the previous information into account, it was decided to use combined rigid fixation on the inferior border of the mandible using trans buccal approach, and non-rigid fixation with miniplates on the superior border of the mandible using transoral approach to combine the advantages of both technique in management of unfavorable displaced mandibular angle fracture.

In this study, maximum mouth opening preoperatively (8.52mm) significantly increased postoperatively to 30.57mm, then significantly increased at 3, 8 weeks, and 6 months. The improved mouth opening after combination of rigid and non-rigid fixation for treatment of bilateral mandibular angle fracture was also reported in another study[2] in which the author reported that combination of rigid and nonrigid fixation has similar complication rates, mandibular mobility indices and functional outcomes to nonrigid fixation. The improved mouth opening after 8 weeks, and 6 months concurred with the finding of Rughubar et al. [2] who noted improved mouth opening after 6 weeks and 3 months post-surgery. Another study comparing miniplate plate to single rigid plate showed that all patients regained normal inter-incisal opening and mandibular movement after 4 weeks.[10]

All cases (13 patients) were detected with pain perioperatively which continued to 3 weeks then significantly decreased at 8 weeks and disappeared after 6 months. Similarly, ELsayed et al. [10] noted that the majority of patients were presented with mild pain postoperatively which decreased after 2 weeks, and the pain disappeared after 8 weeks when they compared a single 2.0-mm locking miniplate to a single rigid 2.3-mm plate in treatment of fractured angle of the mandible.

Seven cases presented with infection preoperatively which significantly decreased to 2 cases postoperatively and disappeared after 3 weeks. Similarly, infection and plate exposure was reported as a common complication in another study[8] in which patients with mandibular angle fracture were treated with 2.0 mm single miniplate at upper border using transoral approach. However, the authors concluded that the use of transoral single miniplates placed along superior border superior is effective and simple approach[8]. In agreement with this observation, another study[10] reported wound dehiscence and infection in 2 patients occurred after 2 weeks with mild swelling, purulent drainage, and moderate pain when single 2.0-mm locking miniplate was used. They also reported infection in one patient with rigid plate due to plate exposure after 2 months with mild mucosal inflammation, pain and a lack of satisfaction. They attributed the dehiscence to the bone plates were placed on the lateral surface of the mandible near its inferior border, which is covered with a thin layer of soft tissue and is an area of muscular movement. Another

suggestion of wound dehiscence is attributed to the occurrence of secondary infection[38]. The infection in this study was attribute to bad oral hygiene and presence of uncontrolled diabetes mellitus. However, in the study of ELsayed et al. [10], the infection was attributed to the impacted third molar which develop infection and cases which extracted the third molar did not show infection. In our study there was no relation of infection to extraction of third molar. A similar observation was reported in another study[39] in which the authors reported no difference in infection whether or not the third molar was removed. Barry and Kearns[4] reported that 8% of patients patients treated with miniplate along the superior border of the mandible showed superficial soft tissue infections which was treated by oral antibiotics.

Three cases were detected with neurosensory disturbance postoperatively and disappeared after 6 months. Similarly, 3 patients were reported with sensory nerve damage and paresthesia when rigid single plate was used in mandibular angle fracture which resolved after 3 months[10]. The sensory disturbance may be attributed to the manipulation of fracture line during surgery and from screw insertion into the inferior alveolar canal[40]. Yadav et al.[8] reported that 54% patients had neurosensory deficit preoperatively and small percent was noted after surgery due to manipulation of fracture line. However, these changes are transient[7]. The improved nerve disturbance in this study was similar to the finding of another study which noted improved nerve disturbances after 6 weeks and complete healing after 6 months. All patients were unable to chew hard food till 8 weeks. This could be attributed to the early removal of the intermaxillary fixation and improvement of maximum mouth opening and decreased trismus.

No cases were detected with malocclusion/ midline shift, malunion, non-union, unsightly facial soft tissue scare, no need for any alternative treatments or loosening of the hardware was detected postoperatively. Malunion or un-union can result from decreased blood supply after surgery[35]. The absence of malunion or un-union was also reported in another study[39]. Similarly, no malocclusion/ midline shift , malunion ,or un-union were reported over the period of 6 months in another study [8] in which patients with mandibular angle fracture were treated with 2.0 mm single miniplate at upper border using transoral approach. In agreement with this observation, ELsayed et al. [10] compared non-rigid miniplate to single plate used for fractured angle of the mandible and found that all cases showed no non-unions, malunions, or improper reductions. They also found a stable occlusion with no functional impairment and no need for surgical revision. However, the author noted facial scars at the transcutaneous incision sites and attributed it to keloid formations on their wounds. The reduced scar formation with transbuccal approach in the current study agreed with the finding of Sugar et al.[28] who noted lower risk of scar formation when the trans-buccal approach is used.

Our study reported lower complication rate associated with combination of rigid and non-rigid fixation of mandibular angle fractures. Conversely, Nakamura *et al*.,[41] demonstrated higher complication rate with miniplate fixation. This could be attributed to the combination of rigid single plate near the inferior border of the mandible and with miniplate along the superior border of the mandible.

CONCLUSION

Within the limitation of this study, combined rigid and semi-rigid fixation using trans-oral and trans-buccal approaches in the management of unfavorable displaced mandibular angle fracture is an effective treatment modality as it was associated with favorable clinical and radiographic outcomes with reduced complications after one year.

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