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MENTAL NERVE INJURY DURING FIXATION OF MANDIBULAR FRACTURES USING TWIN-FORK MINIPLATE

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ABSTRACT

INTRODUCTION: Fractures at the anterior transition zone of the mandible are one of the common fractures treated by oral and maxillofacial surgeons. Since this zone contains the mental nerve, one of the most common postoperative complications is mental nerve paresthesia.

OBJECTIVES: Evaluate the neurosensory disturbances of the mental nerve associated with the twin-fork-miniplate.

MATERIALS AND METHODS: Nine patients with recent mandibular parasymphyseal-body fractures were treated using twin-fork mini-plates. The subjective and objective tests of the mental nerve were conducted after 24-hours, one, four, six, and twelve weeks. In addition, an electrophysiological study was done after one and half months to evaluate the mental nerve's amplitude, onset latency, and conduction velocity.

RESULTS: In the sixth postoperative week, none of the cases complained of numbness, and their response to the objective test was normal. The difference between the healthy and fractured sides was statistically insignificant regarding the sensory nerve amplitude, onset latency, and sensory conduction velocity.

CONCLUSIONS: The use of a twin-fork miniplate resulted in a satisfactory outcome in terms of reducing the disturbance of the mental nerve.

KEYWORDS: Anterior transition zone, Twin-fork miniplate, electrophysiological study

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INTRODUCTION

Mandibular fractures are considered one of the most prevalent facial bone fractures. They constitute the majority of trauma treated by oral and maxillofacial surgeons (1). Motor vehicle accidents and assaults are the most common causes of mandibular fractures. Falls, sports-related injuries, and Occupational-related accidents are also causative factors(2).

There are many classifications for mandibular fractures; Dingman and Natvig classified mandibular fractures by the anatomic areas involved. They classified them as follows: symphyseal, parasymphyseal, body, angle, ramus, condylar process, coronoid process, and alveolar process fracture(3)

The mandible has anterior and posterior transition zones; the anterior one is the region between the parasymphysis and the body. This region is located along the contours of lower canine roots. This area is subjected to strong forces exerted by the pterygomassetric sling(4). Since this transition zone contains the mental nerve, one of the most common postoperative complications after reducing the fractured segment at this is zone is mental nerve paresthesia(5). Fractures at the transition zone between the parasymphysis/ body compromise about 9 % - 57 % of mandibular fractures (6)

In 1973, Michelet et al. introduced easily bendable, non-compression mini plates placed trans-orally and secured with monocortical screws(7). Later on, Champy and his colleagues modified this system and introduced the ideal line of osteosynthesis. The placement of plates along these lines was thought to provide adequate stability and fixation(8).

According to a biomechanical study, Champy defined the ideal osteosynthesis line on the mandible and evaluated the distribution of masticatory stresses along the mandibular regions. The ideal line of osteosynthesis is as follows: behind the mental foramina, the plate is inserted below the roots but above the inferior alveolar canal. At the angle of the jaw, the plate is inserted on the broad inner surface of the external oblique line, and in the anterior region between the mental foramina, due to the torsion strains in this region, two plates should be applied to neutralize it. (8)

Fixation of fractures at the transition zone using two mini plates, one of them subapical and the other one near the lower border, is the technique used nowadays. Although it shows adequate stability of the fractured segments in many cases, it may cause paresthesia of the mental nerve(9)

The Twin-fork miniplate is a newly designed plate by Datarkar. It has an upper horizontal arm that acts as a tension band, and a lower arm acts as a compression band. Both are connected to a single horizontal arm that coincides with the lines of osteosynthesis distal to the mental foramen(10)

This study was done to evaluate the neurosensory disturbances of the mental nerve associated with this newly designed miniplate and to evaluate the biomechanical behavior of the twin-fork-designed miniplate for fixation of fractures at the anterior transition zone of the mandible.

PATIENTS AND METHODS

The clinical part of the study was performed after acquiring the ethical clearance from the Research Ethics Committee(IRB NO:0010556-IORG:0008839), Faculty of Dentistry, Alexandria University.

Nine patients stricken by mandibular fracture have been selected from the cases admitted to the Emergency Ward of Alexandria University Teaching Hospital. All patients signed informed consent before embarking on surgical operation in the Oral and Maxillofacial Surgery Department, Faculty of Dentistry, Alexandria University.

Inclusion criteria

Participated patients suffered from recent, uninfected, and minimally displaced or unfavorable fractures at the parasymphysis-body region of the mandible that should be unilateral, and the fracture should demand open reduction and internal fixation. This study involved adult patients with no gender predilection that agreed to present for follow-up visits for a minimum postoperative period of 3 months. Patients should be medically fit for general anesthesia.

Sample size estimation

The sample size was estimated based on assuming a 95% confidence level and 80% study power. Based on a previous study, ten patients had neurosensory disturbances before using a twin-fork-shaped miniplate, and 10% of them remained with the problem 12 weeks postoperatively(10). The sample size was calculated to be eight patients. This was increased to 9 patients to make up for cases lost to follow-up. The sample size was calculated by G power 3.0.10

Materials

Twin-fork-designed miniplate of 1 mm thickness (Fig. 1). It has an upper horizontal arm serving as a tension band and a lower horizontal arm acting as the compression arm. Both arms are connected to a single horizontal arm, which coincides with the osteosynthesis lines distal to the mental foramen region. 2.0 mini screw, with lengths that range from 5 to 9 mm.

The electrophysiological study was done using the neuropack two electromyograph apparatus (MEB-9400) (Fig. 2)

Preoperative assessment

Complete personal data was obtained, along with the circumstances of the traumatic event, like cause, time, place, and type of assault. Past medical and dental history were recorded for patients, along with a full appraisal of the general state of health. Patients were examined extra orally for detection of any swelling, facial deformity, bleeding, ecchymosis, jaw deviation during function, and soft tissue laceration, and intraorally for detection of the presence of bleeding, lingual hematoma, buccal ecchymosis, malocclusion, midline shift, and teeth integrity was also examined. Palpation was done extra orally for the assessment of any step deformity, tenderness, bony crepitus, condylar movements during opening and closing, and altered lip sensation, and intraorally for the presence of tenderness or alteration in contour. Bimanual manipulation of the mandible on either side of the suspected fracture was done to detect any abnormal segment mobility and tenderness. Mental nerve innervation was compared with the opposite side to conclude the presence of anesthesia or paresthesia. A vitality test was done for teeth in the fracture line.

Radiographic examination

A routine orthopantomograms (OPG) were taken for each patient, followed by a Cone Beam Computed Tomography scan (CBCT-scan) to show the extent of the fracture line, to reveal the degree and direction of displacement, to Show the relation of teeth involved in the fracture line, to help in the localization of inferior alveolar nerve and to help in the adaptation of the twin-fork miniplate. (Fig 3)

Operative procedure

All patients were operated upon under general anesthesia using nasotracheal intubation. The povidone-iodine solution was used to scrub the surgical field, intraoral then extraoral, followed by the draping of the patient with sterile towels revealing only the surgical field. Teeth in the fracture line were managed either by extraction or preservation, as each case indicated. Maxillo-mandibular fixation (MMF) was secured to provide proper occlusion that serves as a guide for fracture reduction. Injection of vasoconstrictor was done to reduce the bleeding and for better visibility. The fracture line was exposed through the intra-oral approach (mandibular vestibular approach). The fracture was mobilized to remove any soft tissue entrapment, and the fractured segments were reduced to the proper anatomical position. The twin-fork miniplate is applied and fixed with about eight mini-screws ranging from 5 to 9 mm, four mesial to the mental nerve and the other four distal to it. Closure of the mentalis muscle layer with vicryl suture material the closure of the mucosal layer with either vicryl or silk suture material(Fig 4). All patients were instructed to apply the ice pack extra-orally, starting immediately postoperatively for 12 hours. , which was replaced by hot fomentation for four days. Instruction of soft, fully liquid, high protein, and high-calorie diet was given to all patients for four weeks postoperatively.

Clinical follow-up

Assessment of the sensory function of the mental nerve was done using three methods the subjective test, the objective test, and the electrophysiological test.

The subjective test was done by asking the patient about any alteration in sensation. The Objective assessment was done using a dental probe pressure to determine any sensory changes along with the distribution of the mental nerve compared to the contralateral side (nociceptive method). (11)

The electrophysiological test was done to evaluate sensory conduction, nerve conduction velocity (NCV), and sensory action potential (SAP) using the neuropack two electromyograph apparatus (MEB-9400). The IAN's sensory nerve conduction was evaluated using the approach given by Jaaskelainen et al. Surface electrodes were used to record the IAN orthodromically. The active recording surface electrodes were inserted approximately 3 cm anterior to the tragus under the zygomatic arch in front of the temporomandibular joint. The reference electrode was applied to the skin just above the zygomatic arch. The ground electrode was placed around the patient's upper arm. The cathode of a bipolar surface-stimulating electrode was put on the mental nerve at its exit from the MF. The site of the premolar and palpation were used to estimate the position of the foramen. Electrical stimuli (0.2 ms square-wave pulses) with intensities three to five times the sensory threshold, ranging from 6 to 15 mA, were used. Sensory IAN onset latency and amplitude were measured in milliseconds and microvolts, respectively.(12, 13)

Radiographic evaluation

The patients were radiographically appraised using an immediate postoperative CBCT-scan to assess the adequacy of fracture line reduction from buccal and lingual perspectives. A CBCT scan was done after three months to assess fracture healing (Fig 5).

Statistical analysis

Subjective and objective mental nerve testing were compared using Cochran's Q test. Wilcoxon Sign Rank test was done to assess changes in Electrophysiological tests between healthy and fractured sides. The significance level was set at a P-value of 0.05. All tests were two-tailed. Data were analyzed using SPSS for windows version 23.

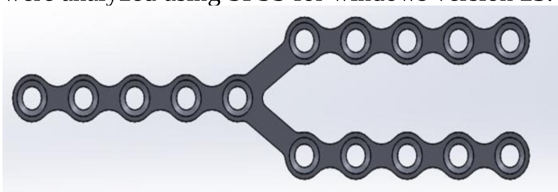

Figure 1: Twin-fork miniplate

Figure 2: Neuropack 2 electromyograph apparatus (MEB-9400) from Nihon kohden (Japan).

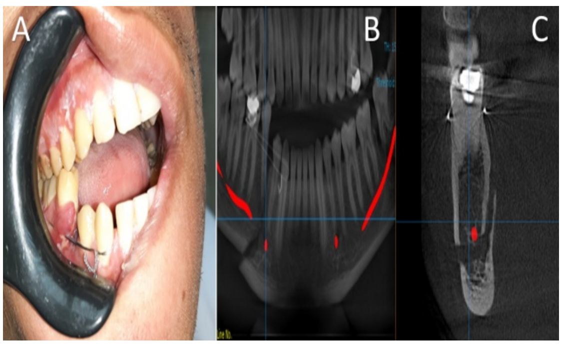

Figure 3: (A) clinical photograph showing preoperative occlusion (B) preoperative panoramic view (C) preoperative axial cut from CBCT showing the fracture line.

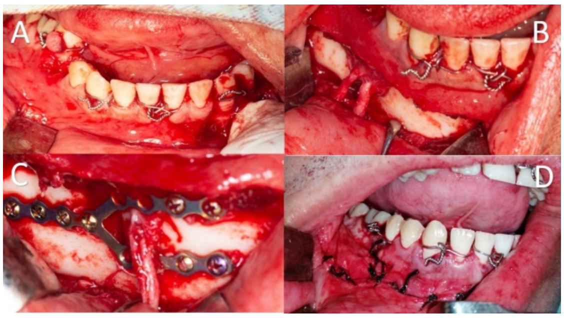

Figure 4: Photographs showing the operative procedures and the fixation of twin-fork miniplate.

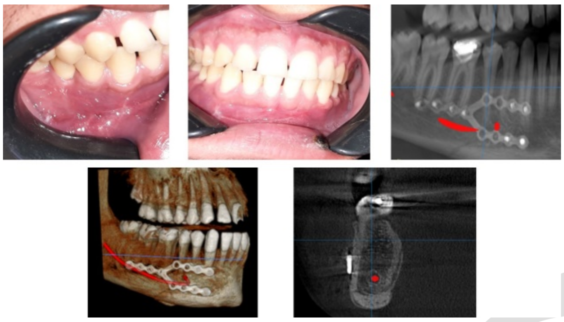

Figure 5: Postoperative occlusion and CBCT showing healing of the fracture

RESULTS

A total of 9 patients were enlisted in this study. The patient's mean age was 30.56± 16.77 years with a male to female ratio of 8:1. The etiological factor of the trauma for all the cases was Road traffic accidents (RTA). (Table 1)

Clinical Evaluation Data

Regarding the subjective test of the mental nerve, There was a significant change in alteration of sensation across time p-value is <0.0001. (Table 2). The objective test also showed a significant difference across time p-value is <0.0001. (Table 3) .For the electrophysiological study, The SNAP amplitudes of the healthy side ranged from (6-11) with a mean value of 8.22 ± 1.94, and that of the fractured side ranged from (5-11) with a mean value of 8.08 ± 2.09, the difference between the healthy and fractured side is not statistically significant p-value = 0.499. (Table 4)In terms of latency, the mean value for the healthy side was 2.94±0.93 ms, and that of the fractured side was 3.67±1.13 ms. The healthy and fractured side latency difference is not statistically significant p-value = 0.156. (Table 5) The mean value of conduction velocity for the healthy side was 35.5±10.5m/s, and for the fractured side, 29.04±10.8m/s. The difference between the healthy and fractured side in conduction velocity is not statistically significant p-value = 0.156. (Table 6)

Table (1): Showing the distribution of the studied cases according to demographic data (n= 9).

Variables		**N=9**
Age: Mean (SD)		30.56 (16.77)
Gender: n (%)	Female	1 (11.1%)
	Male	8 (88.9%)
Cause	RTA	9 (100%)

Table 2: Distribution of Paresthesia of Mental Nerve among the study participants at different time intervals

	Immediate	**1st week**	**4th week**	**6th week**	**12th Week**
Yes: n (%)	8 (88.9%)	8 (88.9 %)	2 (22.2 %)	0 (0%)	0 (0%)
No: n (%)	1 (11.1%)	1 (11.1 %)	7 (77.8 %)	9 (100 %)	9 (100 %)
Cochran's Q Test (P value)	28.000 **(<0.0001*)**				

*Statistically significant difference at *p* value<0.05

Table 3: Distribution of objective Test of Mental Nerve among the study participants at different time intervals

	Immediate	**1st Week**	**4th Week**	**6th Week**	**12th Week**
Pain on stimulus : n (%)	1 (11.1%)	1 (11.1 %)	5 (55.6 %)	9 (100 %)	9 (100 %)
No response: n (%)	8 (88.9%)	8 (88.9 %)	4 (44.4 %)	0 (0%)	0 (0%)
Cochran's Q Test (P value)	26.667 **(<0.0001*)**				

*Statistically significant difference at *p* value<0.05

Table 4: Comparison of Electrophysiological test (amplitude) between the healthy and fractured side

	Healthy side	**Fractured side**
Mean (SD)	8.22 (1.94)	8.08 (2.09)
Median (IQR)	8.00 (4.0)	7.90 (4.0)
Min – Max	6 – 11	5 – 11
Wilcoxson Sign Rank Test (*P* value)	0.676 (0.499)	

*Statistically significant difference at *p* value<0.05

Table 5: Comparison of latency between the healthy and fractured side

	Healthy side	**Fractured side**
Mean (SD)	2.94(0.93)	3.67 (1.13)
Median (IQR)	2.9 (1.81)	3.6 (2.04)
Min – Max	2.00 – 4.2	2.02 – 4.9
Wilcoxson Sign Rank Test (P-value)	**2.67** (0.156)	

*Statistically significant difference at *p* value<0.05

Table 6: Comparison of conduction velocity between the healthy and fractured side

	Healthy side	**Fractured side**
Mean (SD)	35.5 (10.5)	29.04 (10.8)
Median (IQR)	32.7 (20.9)	26.4 (17.15)
Min – Max	23.8 – 47.5	19.4-47.1
Wilcoxson Sign Rank Test (P-value)	2.67 (0.156)	

*Statistically significant difference at *p* value<0.05

DISCUSSION

Treatment of fractures at the anterior transition zone of the mandible without causing neurosensory disturbance to the mental nerve is considered a challenge as dissecting the mental nerve is mandatory to allow placement of a miniplate at the lower border of the mandible. The aim of this study was to evaluate the neurosensory disturbances of the mental nerve associated with the use of the twin-fork miniplate in the management of mandibular fractures at the parasymphyseal-body transition zone and to evaluate the plate's clinical performance through the pain, inter-fragmentary mobility, wound healing, and state of occlusion, along with its radiographic performance through fracture line bone formation.

There was a gender predilection in this study, with a male to female ratio of 8:1, which agrees with other studies (14, 15). The explanation for this higher male ratio may be that men are more exposed to RTA as the percentage of males who ride vehicles and motorcycles is higher than females; also, men are more involved in interpersonal violence than women.

The Etiology of the trauma for all the cases included in this study was RTA. This finding agrees with other studies from developing countries (16, 17). This high incidence of RTA may result from the sudden spread of motorcycles and the lack of following the traffic rules.

Sensory nerve function was evaluated in this study using three methods: subjective test, which depends on the patient's sensation of paresthesia. Objective test (pinprick test) using a sharp probe that touches the patient's mucosa at the site of the mental foramen, and the patient should feel pain if the nerve is not affected. Concerning the subjective test results, 88.9 % felt numbness until the first postoperative week. In the fourth postoperative week, only two cases were still complaining of numbness. Starting from the 6th postoperative week, none of the cases had numbness. The change of the subjective test across time was statistically significant p-value <0.0001.

The objective test results agreed with the subjective test except for the 4th week. This paresthesia could be attributed to the stretching of tissues during the operation or due to soft tissue edema. According to the results obtained from the Datarkar study(10) (2019), 9 out of 10 patients completely recovered from numbness in the third month of the follow-up period.

The third test was the electrophysiological test, which evaluated the mental nerve's amplitude, latency, and conduction velocity using the neuropack two electromyograph apparatus. A sensory nerve conduction study of the mental nerve was done by Nocini (2000)(13), which documented that the mean value of SNAP amplitude of the mental nerve of healthy patients is 9.9 ± 5.5 μv. In our study, the mean value of SNAP amplitude for the fractured side was 8.08 ± 2.09 μv, and for the healthy side, 8.22 ± 1.94 μv. The difference between the amplitude of the healthy side and the side of fracture was statistically not significant p-value= 0.499, which means that the twin-fork miniplate placement didn't compromise the integrity of mental nerve axons.

In this study, the mean latency value for the fractured side was 3.67±1.13 milliseconds. For the healthy side, 2.94±0.93 milliseconds, and the mean value of conduction velocity for the fractured side was 29.04±10.8m/s, and for the healthy side, 35.5±10.5 m/s. The differences in both the latency and the conduction velocity between the healthy and the fractured side were statistically not significant, which means that there was no delay in latency or in the conduction velocity that indicates intactness of the myelin sheath of the mental nerve.

CONCLUSION:

The use of twin-fork mini-plates in the anterior transition zone of the mandible showed satisfactory results in terms of preserving the mental nerve as it eliminates the step of dissecting the nerve's sheath; however, it needs a long incision line for its placement.

CONFLICT OF INTEREST:

The authors declare that they have no conflicts of interest

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