Does the Lag Time Between Injury and Treatment Play a Role in Recovery of Inferior Alveolar Nerve Neurosensory Disturbances Following Mandibular Body Fracture?

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Background: The lag time between injury and treatment (LTIT) plays an important role in reduction of complications in mandibular fractures. The aim of this study was to measure the effect of LTIT on recovery of the inferior alveolar nerve (IAN) neurosensory disturbances (NSDs) following surgical management of mandibular body fractures.

Methods: This was a prospective cohort study. Patients who had a unilateral mandibular body fracture with paresthesia were studied. Paresthesia was evaluated by 2-point discrimination (TPD) test, brush stroke test and self-reporting before and 6 months after the surgical procedure.

Results: Forty-five patients were studied. There was a correlation between LTIT and TPD test result and self-reported paresthesia at 6 months, postoperatively ($P = 0.001$). Fifteen patients (33.3%) had complete improvement in NSD 6 months after treatments (group 1) and 30 patients (group 2) had hyposthesia (N = 17, 37.77%) and paresthesia (N = 13, 28.88%). There was a significant difference in LTIT between groups 1 and 2 at 6 months postoperatively ($P = 0.001$). Cox regression model demonstrated the hazard ratio increased significantly for self-reported NSD when treatment was done 10 days after trauma ($P = 0.001$, confidence level = 95%).

Conclusion: It seems that conduction of open reduction with internal rigid fixation shortly after mandibular fracture may shorten the recovery time of NSDs of the IAN following mandibular body fractures.

Key Words: Mandible, mandibular nerve, neurosensory disturbances, paresthesia

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Mandibular body fractures are generally associated with neurosensory disturbances (NSDs) due to the inferior alveolar nerve (IAN) injury.[1] Nerve injury leads to NSDs of the skin and mucous membranes of the lower lip and the mental area at the side of fracture. This condition usually improves gradually with time.[2] Indirect traumatic nerve bundle injury, compression due to soft-tissue edema, and direct nerve injury by fracture rimes with consequent traction, dislocation, or compression are the main reasons for IAN injury.[3] The prevalence of postinjury/pretreatment IAN deficits ranges from 5.7% to 58.5% in the literature.[4] The prevalence of permanent IAN NSDs after mandibular fracture ranges from 0.9% to 66.7%.[5] Posttraumatic disorders of the IAN can affect the quality of life of patients with mandibular fractures.[3] Anatomical and functional restoration is the main goal of treatment in traumatic injuries.[6]

Nerve injury may happen after injury during open reduction and rigid fixation.[6] Primary nerve injury in mandibular body fractures leads NSD (paresthesia or dysesthesia) which sometimes need no additional treatment rather than open reduction and rigid fixation (ORIF).[6] Many patients have delayed treatments because of concomitant injuries such as head trauma or difficult access to maxillofacial surgery center especially in underdeveloped countries.[7] The lag time between injury and treatment (LTIT) after injuries plays an important role in reduction of complications in mandibular fractures.[8] It is not clear whether the LTIT affects the recovery time of the IAN disturbances after mandibular fractures.

The purpose of this study was to address the following question: Does the LTIT affect the recovery of IAN disturbances in patients with mandibular body fracture who have undergone ORIF? We hypothesized that the LTIT would affect the recovery of IAN disturbances. Therefore, the aim of this study was to evaluate the effect of the LTIT on the recovery of the IAN NSDs following ORIF in patients with mandibular body fracture.

METHODS

Authors designed a prospective cohort study. The study sample was derived from the population of patients who presented to the Department of Oral and Maxillofacial Surgery at Taleghani Hospital for management of mandibular fractures from May 1, 2016 to June 31, 2018. The committee of the medical ethics group of Shahid Beheshti University of Medical Sciences approved this study. Patients eligible for study inclusion had a unilateral mandibular body fracture with paresthesia of the lower lip and mental area, who underwent ORIF, agreed to participate in this study, and returned for the 6-month follow-up visit. Patients were excluded from the study enrollment if they did not have paresthesia, had a history of mandibular trauma, gunshot trauma, mandibular fracture with bone loss, comminuted fractures, any diseases which affect healing process, smokers, pathologic fractures, or severe displacement (more than 5 mm) or failed to return for the follow-up, or refused study enrollment. Edentulous and pediatric (under 18 years) patients were also excluded from the study. Patients with iatrogenic nerve injury intraoperatively were excluded as well.

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Surgical Approach

Arch bars were used to achieve proper occlusion during fixation and for management of the tension band. Fracture site was exposed through a vestibular incision and the mental nerve was identified. The ORIF was done by placement a miniplate and 4 monocortical screws. Mental nerve was observed before closing the incision site for any iatrogenic injury during ORIF. Incisions were closed by 4-0 vicryl. All patients underwent postoperative orthopantomogram (OPG) for reduction confirmation and ruling out any iatrogenic injuries (miss-placement screws and involvement of the inferior alveolar canal and the mental foramen). None of the patients had maxillomandibular fixation following reductions. Elastics were used for 1 to 2 weeks following ORIF. Arch bars were removed 2 months after surgeries. All surgeries were done by an oral and maxillofacial surgeon (RT). The OPG was taken 6 months after ORIF for confirmation healing and any screw or plates displacements or fracture segments malunion.

Neurosensory Evaluation

Paresthesia was evaluated by 2-point discrimination (TPD) test and brush stroke test (semi-objective neurosensory testing [Level A]) before and 6 months after the surgical procedure. The TPD was used as static 2 points in vertical and horizontal direction in the mental area while patient's eyes closed. If patients reported different TPD vertically and horizontally, the mean of TPD was used to statistical analysis. Brush test was conducted across the mental area in the anterior and posterior direction using fine # 2 sable brushes. Patient responses were recorded. Brush tests were done in 2 sessions (in 2 different days) by 2 examiners. If they had different reports, a 3rd examination was done by an independent examiner. The self-reported NSD was documented for each patient before the surgical procedure and after 6 months using a visual analog scale (VAS). In self-reported NSD, 3-6 was considered hypothesia and 7-10 paresthesia.

Patients neurosensory function tests were documented in their files. Neurosensory functions were measured by an oral and maxillofacial surgeon and a dentist (FP and PLK).

Patients were assigned based on NSD at 6 months after treatments into 2 groups: in group 1, patients did not have paresthesia, and in group 2, patients had paresthesia or hyposthesia.

The LTIT was considered as a predictive factor in this study. Age and gender and mechanism of injury were considered as variables, and recovery or level of paresthesia (based on TPD and brush stroke tests) were the outcomes of the study.

Statistical Analysis

The statistical analyses were performed using Statistical package of social Sciences version 21 (IBM Crop, Armonk, NY).

The Pearson's correlation test was applied to evaluate any correlation between the LTIT and paresthesia recovery (TPD test and self-reported paresthesia). Independent *t*-test was used to compare paresthesia recovery between males and females. Analysis of variance test was applied to compare predictive factor and mechanisms of injury. Cox regression model was applied to assess self-reported paresthesia in various treatment times (time-event analysis). An interrater reliability analysis using the Kappa statistic was performed to determine consistency among examiners.

RESULTS

Forty-five patients (30 males, 15 females) were studied. The mean age of patients was 32.38 ± 10.16 years. The mechanism of injury was motor vehicle accident in 24 patients, car accident in 14 patients, falling down in 5 patients and sport injury in 2 patients. The mean of LTIT was 8.22 ± 3.99 days (minimum 2 days and maximum 16 days). None of patients had dysesthesia or anesthesia and infection following mandibular fracture. Obvious nerve injury was not seen in any patient. Analysis of the data did not demonstrate any difference among variables (age, gender, and mechanism of injury) for the mean of duration between injury and treatment (see Supplemental Digital Content, Table 2, http://links.lww.com/SCS/A532). Fifteen patients (33.3%) had complete improvement in NSD 6 months after treatments (group 1) and 30 patients (group 2) had hyposthesia ($N = 17$, 37.77%) and paresthesia ($N = 13$, 28.88%).

The mean TPD value was 11.02 ± 1.97 mm before and 8.49 ± 1.36 mm at 6 months after surgery. The mean score of self-reported NSD (based on a VAS) was 8.40 ± 0.62 before and 4.71 ± 2.18 at 6 months after surgery. The number of patients who reported the true direction in brush stroke test was 11 (23.9%) out of 45 patients before and 23 (51.1%) out of 45 patients at 6 months after surgery (see Supplemental Digital Content, Table 1, http://links.lww.com/SCS/A532).

Analysis of the data did not demonstrate a correlation between age and TPD value ($P = 0.93$). There was no correlation between age and self-reported paresthesia score ($P = 0.94$). The mean age was not different between patients who reported the true direction in brush stroke test and those who reported a false direction ($P = 0.69$, Supplemental Digital Content, Table 3, http://links.lww.com/SCS/A532).

Assessment of the data did not show any difference between males and females for the mean TPD value, self-reported paresthesia score, or the number of patients who reported the true direction in brush stroke test at 6 months, postoperatively ($P = 0.07$, $P = 0.63$, and $P = 0.76$, respectively; Supplemental Digital Content, Table 4, http://links.lww.com/SCS/A532).

The Pearson's correlation test demonstrated a significant correlation between treatment time with TPD value and self-reported paresthesia score at 6 months, postoperatively ($P = 0.001$). There was a significant difference in the LTIT between patients who reported the true direction of brush stroke test at 6 months, postoperatively and those who did not ($P = 0.001$; Supplemental Digital Content, Table 5, http://links.lww.com/SCS/A532).

Analysis of the data did not demonstrate any difference for age and gender between groups 1 and 2 ($P = 0.81$ and $P = 0.37$, respectively) (Supplemental Digital Content, Table 6, http://links.lww.com/SCS/A532). There was a significant difference between 2 groups for LTIT ($P = 0.001$).

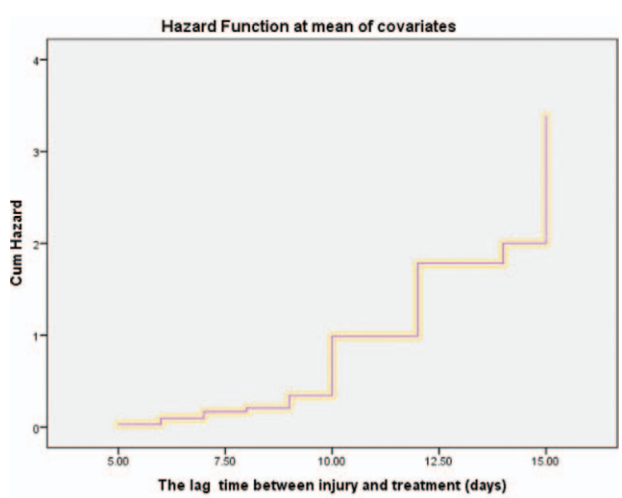

FIGURE 1. Cox regression model demonstrates increased hazard ratio for neurosensory disturbance when treatment is performed 10 days after trauma.

Cox regression model demonstrated the hazard ratio increased significantly for self-reported NSD when treatment was done 10 days after trauma ($P = 0.001$, CL = 95%; Fig. 1). The interrater reliability for the raters was found substantial agreement between examiners (Kappa = 0.73, $P < 0.001$, 95% confidence interval).

DISCUSSION

The LTIT for ORIF may affect the recovery time of the IAN NSDs after mandibular body fracture. This study aimed to evaluate the effect of time of ORIF on recovery of the IAN NSDs after mandibular fractures. The results showed that the recovery time of the IAN NSDs was shortened in most patients in whom, and ORIF was done shortly after the mandibular fracture.

In this study, NSD was assessed subjectively (self-reported paresthesia) and objectively (TPD and brush stroke tests). According to the results, a correlation existed between self-reported paresthesia and the time between injury and treatment. By every 1 day delay in ORIF of mandibular fractures, the recovery index (based on VSA) deteriorated by 0.4. Subjective reports of perceived sensory changes may be initially overestimated or underestimated. Patients may become adapted to these changes and therefore, they may be considered "normal" in long term.[9] The aim of sensory diagnostic tests is to determine whether NSD has occurred, and to measure the magnitude of this disturbance or monitor the sensory recovery and determine whether or not microneurosurgery is indicated.[10] As we evaluated patients with unilateral fracture of the body of mandible, it was easy for patients to compare the level of recovery of NSD at the affected side compared to the intact side. Delay in treatment may result in increased edema, greater displacement of the fragments due to muscle tension specially in unfavorable fractures and increased risk of infection due to saliva leakage or exposure of the fracture site intraorally or extraorally. Moreover, further delay in treatment may cause aberrated healing of the injured nerve and lead to development of a neuroma. Consequently, paresthesia or dysesthesia could be worsened with delay in management. It seems the majority of patients had Sunderland axonometesis (class II) because of improvement of nerve function tests 6 months after ORIF, no obvious nerve injury patients and no patient with more than 5 mm displacement.

Clinical neurosensory testing is generally categorized into 2 basic types based on the specific receptors stimulated through nociceptive, mechanoceptive, and cutaneous contact. Mechanoceptive testing consists of TPD, static light touch, and brush directional stroke tests. The pin-prick and thermal discrimination (and localization, sharp/blunt discrimination, and dental vitality) tests are categorized in the nociceptive testing group. The TPD is used to evaluate large, myelinated, slowly adapting, A-alpha sensory nerve fibers. The sensation of static light touch and brush directional stroke is used to test the discriminating ability of large, myelinated, quickly adapting, A-alpha sensory nerve fibres.[11] In this study, a positive correlation was found between TPD change and the LTIT. It means that when ORIF is done shortly after injuries, patients will diagnose 2 points in a shorter distance than patients with delay treatment. As TPD is a semi-objective neurosensory testing (level A), it may demonstrate an enhancement of recovery in NSD following IAN injury.

Poort et al recommended the light touch test with Semmes-Weinstein monofilaments for grading, and added that a VAS-based questionnaire should be used to evaluate subjective sensibility.[12] Halpern et al studied 61 patients with 97 fractured sides. Their results showed that in 85% of the patients, the IAN neurosensory scores remained unchanged or improved immediately after treatment. In 15% of the patients, the IAN neurosensory status worsened after treatment. Postinjury/pretreatment IAN neurosensory status and fracture displacement were the key factors associated with worsening of the IAN sensory score during the initial postoperative evaluation.[6] However, they did not consider the treatment time as a variable or predictive factor in their study. Tay et al studied the prevalence of NSDs in mandibular fractures. They concluded that IAN injury was 4 times more likely in fractures of the body of mandible (56.2%) than in non-IAN-bearing anterior mandibular fractures (12.6%). Furthermore, the prevalence of the IAN injury at 12 months was higher in the posterior mandible than in the anterior mandible.[13]

Another important factor in evaluation of NSDs and recovery of the IAN is the iatrogenic nerve injuries during ORIF.[14] Song et al demonstrated that inexperience of the operator, fixation with 2 miniplates and fracture displacement of 5 mm or more were associated with an increased risk of deterioration of the NSD after treatment of mandibular fractures.[14] In our study, patients who had iatrogenic injury were excluded from the study. In this study, surgeries were not done by 1 surgeon. Thus, surgeons' experience may also affect the results. This could be considered as a limitation of this study.

CONCLUSION

The IAN injury is among the important postinjury/pretreatment consequences of mandibular body fractures. It seems that conduction of ORIF shortly after the mandibular fracture may shorten the recovery time of the NSDs of the IAN following mandibular body fracture.

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