



# Post-traumatic and postoperative neurosensory deficits of the inferior alveolar nerve in mandibular fracture: a prospective study

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**Abstract** (J Korean Assoc Oral Maxillofac Surg 2016;42:259-264)

**Objectives:** We evaluated and recorded post-traumatic and postoperative neurosensory deficits of the inferior alveolar nerve (IAN) in mandibular fracture in order to identify associated risk factors.

**Materials and Methods:** This was a prospective cohort study composed of 60 patients treated for mandibular fracture. The primary study variable was the change between the post-traumatic IAN neurosensory examination score and the score after fracture reduction. Risk factors were categorized as demographic, anatomic, fracture displacement, and treatment. Appropriate descriptive and bivariate statistics were computed.

**Results:** Sixty patients with unilateral mandibular fracture reported within 24 hours of injury were evaluated over a one-year period. A post-traumatic neurosensory deficit was observed in 52 patients (86.7%), the percentage of which was reduced to 23.3% over the follow-up period. Abnormal post-operative neurosensory scores were significantly higher in angle fracture cases (33.3%) compared to body fracture cases (11.1%). When recovered and non-recovered neurosensory scores were compared by fracture location, 88.9% of body fracture cases showed significant recovery compared to 66.7% of mandibular angle fracture cases. Cases with less than 5 mm fracture displacement showed statistically significantly higher neurosensory recovery scores (90.6%) compared to those with more than 5 mm fracture displacement (60.7%).

**Conclusion:** Use of a miniplate with mono-cortical screws does not play a role in increasing IAN post-traumatic neurosensory deficit. Early management can reduce the chances of permanent neurosensory deficit. Mandibular fracture displacement of 5 mm or more and fracture location were found to be associated with an increased risk of post-traumatic IAN neurosensory score worsening.

**Key words:** Mandibular nerve, Nerve injury, Mandibular fractures

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## I. Introduction

Mandibular fractures between the mental and mandibular foramina frequently result in inferior alveolar nerve (IAN) injury and altered neurosensory function. This may be due to primary injury when the IAN lies in the fracture line or a

secondary insult due to manipulation and fixation of the fracture<sup>1-5</sup>. As a consequence of IAN injury, patients experience subjective disturbances of various intensities, but clinical experience shows that this condition gradually recovers after a certain period of time. Though the primary goal of trauma management is restoration of anatomic form and function, neurosensory deficits cannot be neglected in maxillofacial trauma. For example, teeth anterior to a fracture line can demonstrate disturbed sensitivity; however, the problem has not been addressed sufficiently in the literature<sup>6</sup>. The incidence and long-term outcomes of IAN neurosensory deficits associated with mandibular fractures are insufficiently documented in the literature. Reports reveal that the prevalence of post-trauma IAN deficit ranges from 5.7% to 58.5%<sup>7</sup>. The prevalence of IAN neurosensory deficit after fracture treat-

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ment ranges from 0.4% to 91.3%<sup>5,7-9</sup>. Permanent IAN neurosensory deficits after mandibular fracture range from 0.9% to 66.7%<sup>7,9</sup>.

The current literature, however, is difficult to interpret because of ambiguous and inconsistent sensory testing, censored data, i.e., patients lost to follow-up, variable duration of follow-up, inconsistent terminology, inconsistency with respect to baseline scoring of neurosensory function, or focus on specific treatment techniques<sup>6,10</sup>.

Thus, we decided to evaluate and record post-traumatic and postoperative sensory disturbances of the IAN in mandibular fractures in order to identify associated risk factors.

## II. Materials and Methods

Seventy-three patients (53 males, 20 females) with unilateral mandibular fracture were evaluated and treated between January 2013 and April 2015. Of these, 60 patients (46 males, 14 females) with only 1 fracture per side were enrolled in this prospective study. The Institutional Ethical Committee of BPS Government Medical College for Women approved our study (BPSGMCW/RC153/IEC/16). Inclusion criteria for study enrollment were 1) presence of a unilateral mandibular fracture located between the lingula and mental foramen, i.e., a fracture of the body and angle of the mandible, 2) the availability of preoperative and postoperative panoramic radiographs, and 3) a mental status permitting an adequate neurosensory examination. Patients with a fracture proximal to the lingula and distal to the mental foramen and those incapable of completing an adequate neurosensory examination, such as cases of intoxication, severe head injury, or inability to communicate (e.g., sedated or intubated patients), were not included in this study. Only patients who presented within 24 hours of maxillofacial injury were included and were treated within 72 hours.

The primary study variable was the change between the post-traumatic IAN neurosensory examination score and

the score after fracture reduction. The possible risk factors evaluated were categorized as demographic, anatomic, and post-traumatic neurosensory status. Fracture displacement was categorized as 5 mm or less and greater than 5 mm. One examiner reviewed the panoramic radiographs to determine the degree of fracture displacement. Using the radiographs, measurement of the fracture gap was conducted on the lower border of the angle of the mandible with the help of digital calipers. All of the enrolled patients were treated with mini-plates and mono-cortical screws, i.e., open reduction and internal fixation (ORIF) at the superior border or just below the external oblique ridge, following Champy's technique.

Based on the neurosensory examination, post-traumatic IAN neurosensory status was classified as recovered or non-recovered. On examination, post-trauma patients with IAN neurosensory deficits were considered to have primary IAN injuries. Patients with normal post-trauma neurosensory examinations were therefore at risk of secondary IAN injury due to fracture treatment.

Neurosensory function was evaluated using the protocol described by Zuniga and Essick<sup>11</sup>, including a) sensory (level A)—static light touch, brushstroke direction, and 2-point discrimination; b) proprioception (level B)—measured (sharp/dull) using a pin; and c) response to noxious stimuli (level C)—evaluated using hot/cold sensitivity. We assigned scores to the neurosensory examination ranging from 1 (normal) to 5 (complete anesthetic) as described by Zuniga et al.<sup>12</sup>. (Table 1) An examiner trained and calibrated by one of the researchers performed the IAN sensory examinations.

The outcome variable of interest was the change in IAN neurosensory examination score between the post-traumatic evaluation and the postoperative evaluations at one week, one month, three months, six months, and one year time intervals compared to the normal contralateral side. As such, positive values indicated recovered neurosensory function after treatment. The perioperative change between neurosensory scores was subsequently grouped into 2 categories: recovered after

**Table 1.** Neurosensory scores based on evaluated neurosensory function

Score	Type	Response
1	Normal	The responses on the injured side and the uninjured side exhibited comparable values that were within published normative limits at all three levels of testing. "Normal" does not indicate that the patient was neurologically intact but instead refers to the patient's ability to perform within normative limits and not on his or her report of altered sensation.
2	Mild	Level A test results were abnormal but normal in B and C.
3	Moderate	Level A and B test results were abnormal but normal in C.
4	Severe	Level A and B test results were abnormal and elevated in C.
5	Complete	Level A and B test results were abnormal and absent in C.

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treatment and non-recovered after treatment.

All data were recorded and maintained on an Excel spreadsheet, and analyses were conducted using SPSS version 10 (SPSS Inc., Chicago, IL, USA). A *P*-value less than 0.05 was considered significant.

### III. Results

Sixty patients with unilateral mandibular fracture reported within 24 hours of injury were recruited for the study and were evaluated over a one year period. The sample was analyzed for post-trauma and postoperative neurosensory deficits compared to the normal contralateral side. Out of 60 patients, 46 were male, and the average age was 27 years (range, 16-40 years).

A post-trauma neurosensory deficit was present in 52 of 60 patients (86.7%), the percentage of which was reduced to 23.3% over the one year follow-up period. Table 2 shows the change in neurosensory deficit scores post-trauma and post-operative over time.

Table 3 shows the analysis of the demographic features, fracture displacement, post-trauma neurosensory scores, and postoperative neurosensory scores according to fracture

type, i.e., fracture of the body or of the angle of the mandible. The sample consisted of more male patients (n=46) and a significantly greater number of male patients with a fracture of the angle of the mandible (n=29, 63.0%). The mean age in the two groups based on fracture type was 27.2±7.8 years in the mandibular body fracture group and 27.5±6.5 years in the mandibular angle fracture group. Of the total sample, 55.0% of the cases (n=33) had a fracture of the angle of the mandible compared to 45.0% (n=27) with a mandibular body fracture.

More than 5 mm of fracture displacement was significantly more frequent in the mandibular angle fracture cases compared to the body fracture cases. Less than 5 mm of fracture displacement was seen in 59.4% of cases of mandibular body fracture compared to 40.6% of cases with a mandibular angle fracture.

Post-trauma neurosensory scores were graded as abnormal in 88.9% of cases with a mandibular body fracture and 84.8% of cases with a mandibular angle fracture, the difference between which was not statistically significant. Postoperative neurosensory scores were graded as abnormal in 11.1% cases with a mandibular body fracture compared to 33.3% of mandibular angle fracture cases, which was a statistically signifi-

**Table 2.** Post-traumatic and postoperative neurosensory scores (n=60)

Neurosensory score	Neurosensory deficit				
	Post-traumatic	1 wk postoperative	3 mo postoperative	6 mo postoperative	1 yr postoperative
Normal	8 (13.3)	12 (20.0)	28 (46.7)	43 (71.7)	46 (76.7)
Level A	32 (53.3)	36 (60.0)	25 (41.7)	12 (20.0)	10 (16.7)
Level B	12 (20.0)	6 (10.0)	4 (6.7)	3 (5.0)	2 (3.3)
Level C	8 (13.3)	6 (10.0)	3 (5.0)	2 (3.3)	2 (3.3)

Values are presented as number (%).

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**Table 3.** Analysis of variables by fracture type (n=60)

Variable		Fracture site		<i>P</i> -value
		Body	Angle	
Sample		27 (45.0)	33 (55.0)	
Age (yr)		27.2±7.8	27.5±6.5	
Gender	Male (n=46)	17/46 (37.0)	29/46 (63.0)	0.023
	Female (n=14)	10/14 (71.4)	4/14 (28.6)	
Fracture displacement	More than 5 mm (n=28)	9/28 (32.1)	19/28 (67.9)	0.035
	Less than 5 mm (n=32)	19/32 (59.4)	13/32 (40.6)	
Post-traumatic neurosensory score	Abnormal	24 (88.9)	28 (84.8)	0.719
	Normal	3 (11.1)	5 (15.2)	
Postoperative neurosensory score	Abnormal	3 (11.1)	11 (33.3)	0.043
	Normal	24 (88.9)	22 (66.7)	

Values are presented as number (%) or mean±standard deviation.

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cant difference.

Table 4 shows the analysis of postoperative neurosensory outcomes at the one-year evaluation with respect to demographic features, fracture displacement, post-trauma neurosensory scores, and fracture location. The mean age of cases with recovered neurosensory scores was 26.8±6.9 years, and that of cases with abnormal neurosensory scores was 28.9±7.5 years. There was no statistical difference between cases of recovered and non-recovered neurosensory scores with respect to gender ( $P=0.847$ ). When recovered and non-recovered neurosensory scores were compared by fracture location, 88.9% of cases of mandibular body fracture showed recovery compared to 66.7% of cases with mandibular angle fracture, which was found to be statistically significant ( $P<0.05$ ). Ninety one percent of cases with less than 5 mm of fracture displacement showed recovered neurosensory scores compared to 60.7% of cases with more than 5 mm fracture displacement, which was statistically significant ( $P<0.05$ ).

Post-trauma neurosensory scores had no statistically significant effect on the postoperative neurosensory score ( $P>0.05$ ).

#### IV. Discussion

The incidence of neurosensory deficit in the IAN distribution after mandibular fractures is not well documented. Moreover, there is inadequate information regarding prognosis for recovery of IAN neurosensory function<sup>6,13</sup>. Previous retrospective reviews of mandibular fractures either lack post-trauma sensory information or include fractures that do not involve the mandibular canal. Other retrospective reviews of mandibular fractures do not address sensory changes<sup>4,14,15</sup>. Iizuka and Lindqvist<sup>2</sup> published the most relevant data available on the incidence of sensory deficit after mandibular fractures involving the mandibular canal. This was a study of

sensory disturbances associated with rigid internal fixation of mandibular fractures<sup>2</sup>.

In the present study, the mean age was 27 years (range, 16-40 years). There was no significant association between neurosensory outcome and age or gender. An immediate post-traumatic sensory deficit was found in 86.7% of cases in this patient group. Post-traumatic neurosensory deficits due to indirect injury were not evaluated in the present study as it only considered direct injury to the IAN involved in fracture line. In our study, fracture location was not found to affect post-traumatic neurosensory deficit, and postoperative neurosensory outcomes were not affected by post-traumatic score.

Most authors have reported sensory disturbances as an incidental finding or only in patients who subjectively complained about this problem<sup>6,16,17</sup>. Furthermore, many of these studies included fractures not involving the mandibular canal<sup>16-18</sup>, and others did not address direct injury to the IAN<sup>19-21</sup>.

Iizuka and Lindqvist's report<sup>2</sup> of persistent paresthesia (mean follow-up, 15.9 months) in 46.6% of patients with a post-traumatic sensory deficit is the only relevant information available. However, 76% of these patients had displaced fractures, 30% had edentulous mandibles, and they were all treated with open reduction and rigid internal fixation<sup>2</sup>.

The results of our study indicate that IAN neurosensory scores were recovered after treatment in 76.7% (n=46) of the cases at the one-year follow-up. IAN neurosensory status was abnormal in 23.3% of the cases after treatment. According to Queral-Godoy et al.<sup>22</sup>, quicker healing of the IAN and favorable long-term outcomes are often seen because the nerve is encased within a bony canal. The results suggest that fracture displacement and location are the key variables associated with worsening of the IAN sensory score. Post-trauma IAN neurosensory status and treatment were not found to be associated with worsening of the IAN sensory score. When dis-

**Table 4.** Analysis of variables by neurosensory outcome (n=60)

Variable	Recovered	Non-recovered	P-value
Sample	46 (76.7)	14 (23.3)	
Age (yr)	26.8±6.9	28.9±7.5	
Gender			0.847
	Male (n=46)	11/46 (23.9)	
	Female (n=14)	3/14 (21.4)	
Fracture location			0.043
	Body of the mandible (n=27)	3/27 (11.1)	
	Angle of the mandible (n=33)	11/33 (33.3)	
Fracture displacement			0.006
	More than 5 mm (n=28)	11/28 (39.3)	
	Less than 5 mm (n=32)	3/32 (9.4)	
Post-traumatic neurosensory score			0.179
	Abnormal (n=52)	14/52 (26.9)	
	Normal (n=8)	0/8 (0)	

Values are presented as number (%) or mean±standard deviation.

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placement of the fracture line was present, a greater incidence of neurosensory deficit and more prolonged recovery should be expected. The suspected reasons for this are trauma to the nerve by the displacement itself and additional trauma during surgical reduction and repair<sup>23</sup>.

Patients with a fracture displaced more than 5 mm had increased risk of an adverse effect on the neurosensory score after treatment compared with patients with fractures displaced 5 mm or less. As all patients were treated with ORIF with mini-plates, mono-cortical screws, and anatomical placement, the risk of a worsening of the IAN sensory score after treatment was low. Stacey et al.<sup>24</sup> reported that the use of non-compressive miniplate fixation of mandibular fractures is effective due to its low morbidity and complications.

The strengths of the current study are its prospective design and consistency of collection of IAN sensory data during the postoperative period. The method of neurosensory measurement used is well documented, suitable for perioperative evaluations, and commonly used in follow-up studies of mandibular fracture treatment<sup>12,25-27</sup>.

We may hypothesize that the duration between injury and management could play an important role in neurosensory outcome. In our study, the duration between injury and presentation for treatment was restricted by only recruiting patients reporting within 24 hours of injury. The neurosensory deficit examination was conducted on the seventh postoperative day.

The results of the present study suggest that the IAN neurosensory status is recovered after mandibular fracture treatment in most patients. IAN neurosensory status worsening was not observed after treatment. This is consistent with the results of a study by Schultze-Mosgau et al.<sup>23</sup>, in which there was no increase in neurosensory deficits after surgical treatment.

In the present study, risk factors affecting the neurosensory outcome were found to be fracture location and fracture displacement. Recovery of neurosensory deficit postoperatively was observed less often in cases with fracture displacement of more than 5 mm compared to cases with less than 5 mm fracture displacement, i.e., 60.7% vs 90.6% ( $P=0.006$ ). Another significant factor affecting the outcome was fracture location, i.e., neurosensory recovery was observed more often in mandibular body fracture of mandible compared to mandibular angle fracture (88.9% vs 66.7%). Similar results of fracture displacement being a key factor in neurosensory outcomes were found by Halpern et al.<sup>1</sup>, Marchena et al.<sup>6</sup>, Schultze-Mosgau et al.<sup>23</sup>, and Bede et al.<sup>28</sup>. Another noteworthy

finding was that a greater number of angle fracture cases showed more than 5 mm displacement (67.9%).

## V. Conclusion

The use of a miniplate with mono-cortical screws does not play a role in increasing the risk of neurosensory deficit. Mandibular fracture displacement of 5 mm or more was associated with an increased risk of deterioration of post-traumatic IAN neurosensory score. Fracture location was also found to be associated with postoperative neurosensory outcomes i.e., mandibular body fracture cases had better neurosensory outcomes compared to mandibular angle fracture cases. Age and gender did not significantly affect the IAN deficits. Early management can reduce the risk of permanent neurosensory deficits. Additional studies are needed to determine long-term IAN neurosensory function after mandibular fracture treatment and factors that affect prognosis.

## Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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