

# Risk factors for hypesthesia after repair of facial fractures

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**Objective.** The aim of this study was to investigate the incidence of hypesthesia in patients with facial bone fractures and to identify the relationships between posttraumatic hypesthesia and risk factors, including general and fracture-related characteristics.

**Study Design.** A total of 437 patients who underwent surgery for facial bone fractures were included. Clinical neurosensory testing was performed at different time points (immediately after trauma and 1 week, 1 month, and 6 months after surgery). The results of these assessments were compared with regard to characteristics and fracture sites.

**Results.** The hypesthesia incidences were highest in the mandible (19.1%), maxilla (18.3%), and orbit (8.5%). Sensation was recovered by 97.3% of all patients by 6 months after surgery. Risk factors for hypesthesia were direct nerve injury ( $P = .002$ ), distance ( $\leq 10$  mm) between the fracture and nerve foramen ( $P = .002$ ), the amount of bony displacement ( $P = .035$ ), and age ( $P = .004$ ). There were significant differences among the fracture sites.

**Conclusions.** Posttraumatic hypesthesia increased temporarily after surgery, but most patients recovered by 6 months postoperatively. Recovery from postoperative hypesthesia was related to the fracture site and pattern. Cases in which the patient did not recover involved direct nerve injury. (Oral Surg Oral Med Oral Pathol Oral Radiol 2019;128:366–372)

Maxillofacial trauma accounts for a substantial percentage of traumatic injuries.<sup>1</sup> This is because the facial bones protrude and are more likely to be damaged by external forces.<sup>2,3</sup> In most cases of facial fractures, surgical treatment is necessary for restoration of morphology and function.<sup>4,5</sup> Surgical procedures for facial bone fractures may cause complications, such as asymmetry, neurologic hypesthesia, disturbed wound healing, infection, malocclusion, nonunion, and malar depression; hypesthesia is one of the most common complications.<sup>5-7</sup>

Because the face has a high density of peripheral receptors, the prevalence of sensory deterioration caused by trauma ranges from 70% to 81%.<sup>6,8,9</sup> Posttraumatic hypesthesia is caused by direct nerve injury resulting from the fracture and indirectly by soft tissue edema.<sup>10</sup> In addition, hypesthesia can be induced indirectly by surgical procedures, such as the incision and dissection of tissues and traction from surgical instruments.<sup>11,12</sup> This deterioration in sensation decreases the patient's quality of life.<sup>13</sup>

Although trauma characteristics are not limited to the site of facial bone fracture, previous studies were limited by small sample sizes and the relevant factors investigated.<sup>4,14</sup> The purpose of this study was to analyze the general and fracture-related characteristics of facial bone fractures and to investigate the relationships between risk factors and posttraumatic hypesthesia.

## MATERIALS AND METHODS

### Study design

This was a single-center, retrospective cohort study. The study included 557 patients who had suffered facial bone fractures and had undergone treatment between July 2010 and December 2016 at Pusan National University Hospital. In cases where 2 or more fractures were diagnosed, only the more displaced fracture was included, making up a total of 437 patients included in the study. The exclusion criteria were as follows:

1. Those who underwent nonsurgical treatment
2. Pathologic fractures
3. Incomplete computed tomography data and chart data
4. Those who were not followed up for at least 6 months

The endpoint was completed less than 6 months after surgery.

Surgical procedure was carried out according to Association for Osteosynthesis/Association for the Study of Internal Fixation guidelines. Internal fixation of the metal plate or absorbent plate was performed with an open reduction through an extraoral/intraoral approach. Surgical procedure was performed by the same oral and maxillofacial surgeon.

Hypesthesia was examined immediately after the trauma and at 1 week, 1 month, and 6 months after surgery. A neurologic examination was used to assess the degree of hypesthesia, utilizing questionnaires and a

## Statement of Clinical Relevance

After facial trauma, posttraumatic hypesthesia increased temporarily after surgery. But most patients recovered by 6 months postoperatively. It is important to know the recovery tendency and related risk factors of facial bone fractures.

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visual analogue scale (VAS), which was graded from 0 (no sensitivity) to 100 (completely normal sensitivity).<sup>15</sup>

The study patients were divided into 2 groups: (1) Yes group: patients with hypesthesia (those with VAS scores less than 100 based on neurosensory measurements); and (2) No group: patients with normal sensation.

The control group included those with VAS scores of 100 based on neurosensory measurements.

Patient information and data collection were performed in a double-blinded manner. Additionally, medical records were reviewed, and radiographic measurements were performed. To increase measurement accuracy, 2 measurements were taken with a 2-week interval, and the mean value was calculated. The intraclass correlation coefficient was 0.95.

Fracture sites were categorized into 4 types: (1) orbital bone fractures, which included orbital floor, roof, medial, and lateral bone fractures; (2) nasal bone fractures, which included nasal and septal bone fractures; (3) maxillary bone fractures, which included zygomatic bone, zygomaticomaxillary complex, and Le Fort I, II, and III bone fractures; and (4) mandibular bone fractures, which were divided according to 3 locations (Figure 1).

**Study variables**

Details of the characteristics mentioned above, as well as the demographic characteristics of the included patients, are listed in Table I. Patient-related factors included sex, age, body mass index, past medical history, and smoking status. Fracture-related characteristics included occlusion, fracture type, and cause of

trauma. Surgery-related factors included the maxillo-mandibular fixation period, duration between the injury and operation, and fixation materials.

**Data analysis**

Data were analyzed by using the SPSS statistical software (SPSS Inc., Chicago, IL). The Kolmogorov-Smirnov test was used to test for normality. Median, interquartile range, and frequency are presented, and the differences between the 2 groups were compared by using the Mann-Whitney U test and the  $\chi^2$  test. General and fracture-related characteristics for risk factors were used in logistic regression analyses. Results of the statistical analysis with *P* values less than .05 were considered statistically significant.

**Ethical considerations**

This study was approved by the hospital’s Ethics Review Committee (No. H-1712-005-062).

**RESULTS**

In the posttrauma evaluation of the degree of hypesthesia after facial bone fracture, the mandibular fracture group had the lowest score (87.69 points), followed by the maxillary fracture group (90.11 points). There was no hypesthesia in the nasal bone fracture group. All patients except those with nasal bone fractures had lower scores (78.28–100.00 points) 1 week after surgery than in the immediate posttrauma period. The degree of hypesthesia after trauma differed according to the traumatized region, but eventually, 97.3% had recovered 6 months postoperatively (Figure 2). According to the site, mandibular fractures showed the highest incidence of hypesthesia after trauma, whereas that of maxillary fractures was highest after surgery (see Table I).

In Table II, we present the general and fracture-related characteristics of patients with facial bone fractures. When the hypesthesia group and the control group were compared, there were significant differences in occlusion (*P* = .048), fracture type (*P* < .001), direct nerve injury (*P* < .001), distance between the fracture line and nerve foramen (*P* < .001), and amount of bony displacement (*P* < .001). With regard to occlusion, posttraumatic unstable occlusion was present in 40.7% in the hypesthesia group and in 28.8% in the control group. With regard to the fracture site, there was no hypesthesia in the nasal bone fracture group. In the hypesthesia group, mandibular fracture was the most frequent (64.4%). In contrast, 42.6% of the control group demonstrated a difference in the ratios between fracture sites. In terms of age, patients younger than 30 years of age were 2.29 times more likely to present hypesthesia compared with those older than 30 years of age (*P* = .004). The incidence of hypesthesia was 11.09 times higher when the fracture

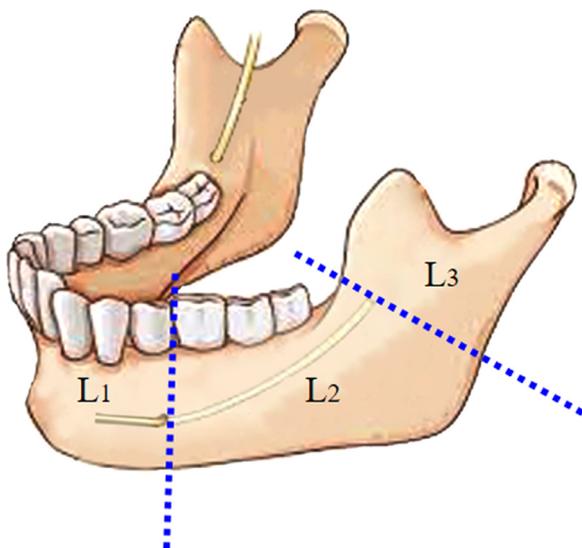


Fig. 1. Schematic diagram of mandible according to fracture site; Location 1 (L<sub>1</sub>: Located between both mental foramens), Location 2 (L<sub>2</sub>: Located between the mental and mandibular foramens), and Location 3 (L<sub>3</sub>: Located distal to the mandibular foramens).

**Table I.** Rates of hypesthesia according to fracture type (N = 437)

Categories	Posttrauma	1 week postoperatively	1 month postoperatively n (%)	6 months postoperatively
Orbital (n = 47)	4 (8.5)	12 (25.5)	9 (19.1)	—
Nasal (n = 98)	—	—	—	—
Mx. (n = 93)	17 (18.3)	36 (38.7)	31 (33.3)	4 (4.3)
Mn. (n = 199)	38 (19.1)	60 (30.2)	40 (20.1)	7 (3.5)

Mn., mandibular; Mx., maxillary.

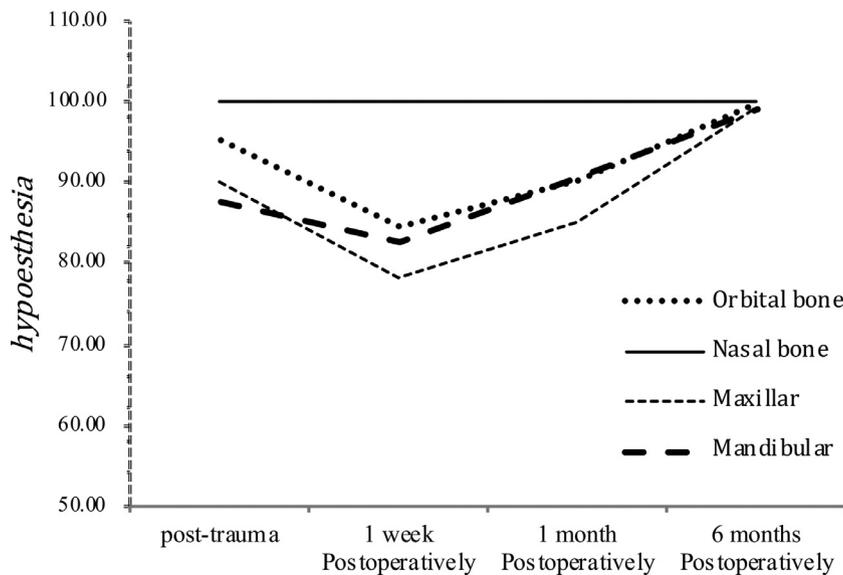


Fig. 2. Recovery of nerve injury according to fracture types.

line was superimposed on the nerve ( $P = .002$ ). When the distance between the fracture line and the nerve foramen was greater than 10 mm, the incidence of hypesthesia was 4.65 times higher. Moreover, when the amount of bony displacement exceeded 9.1 mm, it was 4.62 times higher ( $P = .035$ ).

In maxillary fractures, the ratios in the hypesthesia and control groups were similar in cases where the nerve was damaged directly. In the mandible, the hypesthesia group showed a higher rate compared with the control group. Moreover, 24.2% of patients did not show symptoms even if it was related directly to the nerve (Table III). In orbital fractures, direct nerve injury was thought to be the cause of hypesthesia. Therefore, the effect of the distance between the nerve foramen and the fracture line on hypesthesia was measured in the maxilla and the mandible. The measurements showed that hypesthesia occurred at a distance of less than 10 mm in both the maxilla and the mandible (Table IV). Table V shows that there was a significant difference between the 2 groups when the displacement of the fracture exceeded 9.1 mm. When the displacement was analyzed according to the fracture site, a significant difference was observed in the

location 2 ( $L_2$ ) group. This suggests that hypesthesia is more likely to occur as the amount of displacement increases in the mandibular body area.

**DISCUSSION**

In this study, we investigated hypesthesia incidence and healing progression after facial bone trauma and analyzed general and fracture-related characteristics between patients with hypesthesia and the control group. Hypesthesia was present in 13.50% of the 437 patients, and symptoms had resolved in 97.3% of these patients 6 months postoperatively. The prognosis of hypesthesia after facial fracture in the present study is similar to those reported in previous studies. The prevalence rates of hypesthesia ranged from 46.5% to 53.84% among orbital fractures<sup>16,17</sup> and from 27.90% to 79.90% among maxillary and mandibular fractures<sup>18</sup>; the prevalence of hypesthesia among nasal bone fractures was 3.47%.<sup>19</sup>

Postoperative hypesthesia was more severe in the remaining fracture types except for those of the nasal bone. This resulted from surgical trauma, such as incision, perineural dissection, and traction from instruments, which was reported to occur in 50% to 90% of

**Table II.** Comparative analysis of the characteristics in the 2 groups (N = 437)

Characteristics	Categories	Hypesthesia		$\chi^2/U$	P	OR	95% CI	P	
		Yes (n = 59)	No (n = 378)						
		n (%)							
Sex	Male	47 (79.7)	303 (80.2)	0.01	.929	1.03	0.52–2.04	.929	
	Female	12 (20.3)	75 (19.8)						
Age (years)	0–9	–	9 (2.4)	13.45	.143	2.29	1.30–4.03	.004	
	10–19	14 (23.7)	59 (15.6)						
	20–29	23 (38.9)	93 (24.5)						
	30–39	9 (15.3)	67 (17.7)						
	40–49	4 (6.8)	54 (14.3)						
	50–59	5 (8.5)	55 (14.6)						
	60–69	4 (6.8)	26 (6.9)						
	70–79	–	11 (2.9)						
	≥80	–	4 (1.1)						
Occlusion	Stable	35 (59.3)	269 (71.2)	3.38	.048	–	–	–	
	Unstable	24 (40.7)	109 (28.8)						
PMH	Yes	19 (32.2)	85 (22.5)	2.65	.103	1.62	0.47–5.51	.436	
	No	40 (67.8)	293 (77.5)						
Current smoker	Yes	17 (28.8)	152 (40.2)	2.79	.095	1.60	0.51–5.06	.418	
	No	42 (71.2)	226 (59.8)						
Trauma cause	Collision	10 (16.9)	55 (14.6)	6.05	.534	–	–	–	
	Slipping	22 (37.3)	114 (30.2)						
	Assault	12 (20.3)	60 (15.9)						
	Falling down	5 (8.5)	60 (15.9)						
	Traffic accident	10 (16.9)	74 (19.6)						
	Sports trauma	–	8 (2.1)						
	Industrial accident	–	7 (1.8)						
Fixation material	Metal	47 (79.7)	205 (73.2)	1.06	.330	4.29	0.53–34.34	.169	
	Absorbable	12 (20.3)	75 (26.8)						
Fracture type	Orbital	4 (6.8)	43 (11.4)	23.45	< .001	<0.01	–	.997	
	Nasal	–	98 (25.9)						
	Mx.	17 (28.8)	76 (20.1)						
	Mn.	38 (64.4)	161 (42.6)						
DNI	Yes	36 (61.0)	106 (28.0)	25.29	< .001	11.09	2.39–51.35	.002	
	No	23 (39.0)	272 (72.0)						
DBFN (mm)	0.0–10.0	49 (83.1)	137 (48.9)	23.52	< .001	4.65	1.76–12.22	.002	
	10.1–20.0	5 (8.5)	65 (23.2)						
	20.1–30.0	5 (8.5)	60 (21.4)						
	≥30.1	0 (0.0)	18 (6.4)						
DF (mm)	0.0–3.0	38 (64.4)	185 (66.1)	23.90	< .001	–	–	–	
	3.1–6.0	8 (13.6)	61 (21.8)						
	6.1–9.0	1 (1.7)	23 (8.2)						
	≥9.1	12 (20.3)	11 (3.9)						
MMF period (days)*	Median (Q3-Q1)	10.0 (12.0-8.0)	10.00 (12.00-9.00)	0.95	.396	1.14	1.05–1.25	.487	
BMI (kg/m <sup>2</sup> )*		21.51 (23.88-19.84)	21.28 (23.44-19.18)	0.69	.467	1.09	0.97–1.23	.108	
TSP (days)*		5.00 (7.00-3.00)	5.00 (7.00-3.00)	0.72	.466	0.78	0.59–1.02	.075	

\*Mann-Whitney U test.

In the Kolmogorov-Smirnov test results, a P value of .05 or less was used as a nonparametric test and expressed as a median value. *BMI*, body mass index; *DBFN*, distance between the fracture and nerve; *DF*, displacement of the fracture; *DNI*, direct nerve injury; *IQR*, interquartile range; *MMF*, maxillo-mandibular fixation; Mn. = mandibular; Mx. = maxillary; *PMH*, past medical history; *TSP* = trauma–surgery period.

patients.<sup>4,20</sup> Hypesthesia caused by surgical trauma is known to resolve most rapidly within 2 weeks of surgery.<sup>4</sup> In this study, only 8 patients (1.83%) presented hypesthesia after 6 months (data not shown).

In this study, occlusion was more unstable in the hypesthesia group. Causes of posttraumatic occlusion after facial bone fracture include hematoma, edema, a displaced fracture fragment, and the restriction of muscle movement from a displaced fracture fragment.<sup>21</sup>

This finding can be interpreted as a result of fractures of the zygomaticomaxillary complex; occlusal disturbances were found only in patients with displaced fractures.<sup>21,22</sup> Displaced fractures of the facial bones can increase the possibility of damage to the trigeminal nerve, which can be linked directly to hypesthesia. Furthermore, care should be exercised in predicting this situation and to avoid exacerbating it with surgical trauma. Risk factors were age, direct nerve injury,

**Table III.** Rates of direct nerve injury according to fracture type (N = 437)

Categories	Hypesthesia	
	Yes n (%) / Total number of patients	No n (%) / Total number of patients
Orbital (n = 47)	3 (75.0)/4	19 (44.2)/43
Nasal (n = 98)	0 (0.0)/0	0 (0.0)/98
Mx. (n = 93)	7 (41.2)/17	30 (39.5)/76
Mn. (n = 199)		
L <sub>1</sub> (n = 57)	0 (0.0)/12	0 (10.0)/45
L <sub>2</sub> (n = 83)	26 (100.0)/26	57 (100.0)/57
L <sub>3</sub> (n = 59)	0 (0.0)/0	0 (0.0)/59

L<sub>1</sub>, fracture located between the lingual and mental foramen; L<sub>2</sub>, fracture located between the mental and mandibular foramen; L<sub>3</sub>, fracture located distal to the mandibular foramen; Mn., mandibular; Mx., maxillary.

distance between the fracture and nerve, and displacement of the fracture. In relation to age, facial trauma and fractures are generally known to occur in the 30s or younger age group.<sup>23,24</sup> These characteristics of facial bone fractures were reported to be highly prevalent among patients 21 to 30 years of age. In this study, the hypesthesia group showed a significant difference in the ratio of patients younger than 30 years of age.

Direct nerve injury was shown to be a risk factor for hypesthesia after facial bone fracture in many studies.<sup>4,7,10,23</sup> In the present study, hypesthesia was observed in about 60% of patients, and 40% of patients had no symptoms. In addition, hypesthesia was observed in about 30% of cases where the nerve was not involved, and it was thought that hypesthesia occurred because of other indirect factors. The reason is that the trigeminal nerve, which is the sensory nerve for the facial bones, extends to the periphery through relatively long bony canals. The large layer of soft tissue covering the emergences of the inferior alveolar nerve and the infraorbital nerve offers protection from direct trauma.<sup>25</sup>

In the present study, a fracture with a maximal displacement greater than 9.1 mm was identified as a risk factor. This finding is similar to those of previous studies, which showed that a mandibular fracture with a displacement greater than 5 mm conveyed a 7-fold higher risk of damage to the inferior alveolar nerve. Hypesthesia becomes worse as displacements become larger when nerve involvement is inevitable, such as in the mandibular body area.<sup>23,26</sup> However, it is known that a large displacement does not delay recovery from hypesthesia.<sup>26</sup> The results showed that recovery was observed after 6 months in all patients with a displacement greater than 9.1 mm. Recovery from hypesthesia is known to be influenced by various factors, such as age, medical history, infection, and smoking status.<sup>5,7,23,24</sup>

In the present study, 11 patients had persistent hypesthesia even after 6 months. Three patients presented hypesthesia after trauma that lasted up to 6 months postoperatively. In addition, 8 patients presented hypesthesia, which persisted for 6 months postoperatively.

**Table IV.** Rates according to the distance between the fracture line and nerve (N = 292)

Type	Hypesthesia					No						
	Yes					No						
	n (%)											
	0.0–10.0 mm	10.1–20.0 mm	20.1–30.0 mm	≥ 30.1 mm	0.0–10.0 mm	10.1–20.0 mm	20.1–30.0 mm	≥ 30.1 mm	0.0–10.0 mm	10.1–20.0 mm	20.1–30.0 mm	≥ 30.1 mm
Mx.	17 (100.0)	—	—	—	46 (60.5)	13 (17.1)	7 (9.2)	10 (13.2)	—	—	—	—
Mn.												
L <sub>1</sub>	3 (25.0)	4 (33.3)	5 (41.7)	—	1 (2.2)	21 (46.7)	23 (51.1)	—	—	—	—	—
L <sub>2</sub>	26 (100.0)	—	—	—	57 (100.0)	—	—	—	—	—	—	—
L <sub>3</sub>	—	—	—	—	11 (18.6)	27 (45.8)	21 (35.6)	—	—	—	—	—

L<sub>1</sub>, fracture located between the lingual and mental foramen; L<sub>2</sub>, fracture located between the mental and mandibular foramen; L<sub>3</sub>, fracture located distal to the mandibular foramen; Mn., mandibular; Mx., maxillary.

**Table V.** Rates according to the displacement of the fracture line (N = 437)

Type	Hypesthesia										$\chi^2$	P
	Yes					No						
	n (%)											
	0.0–3.0 mm	3.1–6.0 mm	6.1–9.0 mm	≥ 9.1 mm	0.0–3.0 mm	3.1–6.0 mm	6.1–9.0 mm	≥ 9.1 mm				
Orbital	3 (75.0)	1 (25.0)	—	—	26 (60.5)	13 (30.2)	3 (7.0)	1 (2.3)	0.53	—	—	.912
Nasal	—	—	—	—	—	—	—	—	—	—	—	—
Mx.	13 (76.5)	2 (11.8)	0 (0.0)	2 (11.8)	57 (75.0)	10 (13.2)	7 (9.2)	2 (2.6)	4.28	—	—	.232
Mn.	10 (83.3)	1 (8.3)	0 (0.0)	1 (8.3)	29 (64.4)	11 (24.4)	3 (6.7)	2 (4.4)	2.73	—	—	.434
L <sub>1</sub>	12 (46.2)	4 (15.4)	1 (3.8)	9 (34.6)	39 (68.4)	10 (17.5)	4 (7.0)	4 (7.0)	10.47	—	—	.015
L <sub>2</sub>	—	—	—	—	34 (57.6)	17 (28.8)	6 (10.2)	2 (3.4)	—	—	—	—
L <sub>3</sub>	—	—	—	—	—	—	—	—	—	—	—	—

L<sub>1</sub>, fracture located between the lingual and mental foramina; L<sub>2</sub>, fracture located between the mental and mandibular foramina; L<sub>3</sub>, fracture located distal to the mandibular foramen; Mn., mandibular; Mx., maxillary.

All these cases showed common features of a fracture line and nerve superposition, suggesting that direct nerve injury has a significant impact on the prognosis of hypesthesia.

**CONCLUSIONS**

This retrospective study was performed to evaluate hypesthesia characteristics and risk factors in patients who underwent surgery for facial bone fractures. It is important to confirm that hypesthesia is related to the characteristics of the fracture; the distance and amount of displacement from the fracture line are important factors. We hope that these data provide useful information about patient outcomes and prognoses in cases of hypesthesia.

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