Multivariate relationships among risk factors and hypoesthesia of the lower lip after extraction of the mandibular third molar

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Objective. In this study, we investigated the multivariate relationships among risk factors and hypoesthesia of the lower lip.

Study design. Various risk factors of hypoesthesia of the lower lip after mandibular third molar extraction were investigated by univariate and multivariate analyses.

Results. Applying the logistic regression model and forward stepwise algorithms, canal observed, remarkable hemorrhage, loss of the white line of the root, diversion of the canal, and close relationship of the roots to the inferior alveolar nerve were identified as significant variables.

Conclusions. Procedure-related factors during surgery, such as canal observed and remarkable hemorrhage, and radiographic signs, such as loss of the white line of the root, diversion of the canal, and close relationship of the roots to the inferior alveolar nerve, were high risk factors of hypoesthesia of lower lip after extraction. (Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2011;111:e1-e7)

Mandibular third molars show the highest incidence of impaction and are considered to be responsible for diseases such as pericoronitis, periodontal defects posterior to the second molars, caries in the second and third molars, neurogenic and myofacial pain, odontogenic cysts and tumors, and primary or secondary crowding of the dentition.1,2 Therefore, removal of these teeth to prevent such problems is widely recommended and one of most commonly performed surgical procedures in oral surgery. However, the mandibular third molars are usually located near the inferior alveolar nerve. The surgical removal of these molars may damage the nerve and cause hypoesthesia of the lower lip, which is one of the most unpleasant postoperative complications.1-27 Therefore, preoperative assessment must be carried out radiologically in an attempt to identify the proximity of the impacted tooth to the inferior alveolar canal. This evaluation is the first stage in assessing the possible postoperative occurrence of hypoesthesia of the lower lip, thus ensuring its prevention.3,5,7,10,14,15,17-25 Other factors reported to be associated with mandibular third molar complications include age, gender, surgeon experience, and the difficulty of extraction.15,7,10,14,15,18-22,24-27 Assessments of these factors must also be carried out. Many investigators reported hypoesthesia of the lower lip associated with mandibular third molar removal.1-27 However, these studies have few quantitative analyses of the factors contributing to hypoesthesia of the lower lip. In addition, only a few studies to date have evaluated the multivariate relationships among risk factors and hypoesthesia of the lower lip.21,26,27 We hypothesized that one or more risk factors associated with postoperative hypoesthesia of the lower lip could be identified that would enhance patient outcome. In the present study, we investigated the multivariate relationships among risk factors and hypoesthesia of the lower lip.

PATIENTS AND METHODS
The Institutional Review Board of Kobe Steel Hospital approved this study, and informed consents were obtained from all of the patients involved. Between April 2006 and April 2009, 2,528 surgical removals of mandibular third molars were performed by the dentists at the Department of Oral and Maxillofacial Surgery, Kobe Steel Hospital, Kakogawa. Before surgery, each patient was informed about possible complications, including the potential risk of nerve damage during the procedure, and each patient provided full informed consent.
Every intervention was carried out under local or general anesthesia. Envelope (sulcular) mucoperiosteal flaps were raised for superficial impactions, and triangular flaps were raised for deep impactions, followed by vestibular bone removal. Bone removal and sectioning were performed with tungsten fissure burs (CH-1338; Dentsply, Ballaigues, Switzerland). Sockets were irrigated with 20 mL sterile saline solution at room temperature, and exposure of the inferior alveolar nerve was checked during and after precisely focused careful suction. A 3-0 silk suture was used to close the wound. An antibiotic and an antiinflammatory drug were prescribed (usually oral cefcapene pivoxil hydrochloride 900 mg 3 times daily for 3 days and oral acetaminophen 1,200 mg 3 times daily for 3 days). After 7 days, a surgeon removed the suture.

Study design

Patients who underwent conventional panoramic radiographs (Orthoceph OC100CT; Yoshida, Tokyo, Japan) were included in the study, and the films were analyzed by the first two authors. The primary predictive variable was the presence or absence of one or more preoperative panoramic radiographic findings. The relationship of the roots to the inferior alveolar nerve was diagnosed radiographically according to the methods of Tanaka et al.28 (Fig. 1). In type 1 cases, the canal superimposed more than one-half of the root structure. In type 2 cases, the canal superimposed less than one-half of the root structure. In type 3 cases, the root structure impinged the superior border of the canal. In type 4 cases, the distance between the root tip and superior border of the canal was <2 mm. In type 5 cases, the distance between the root tip and superior border of the canal was >2 mm. Other preoperative radiographic findings, such as the type of impaction (according to Pell and Gregory),30 angulation (Winter classification),30 loss of the white line of the root, and diversion of the canal, procedure-related factors during surgery, such as canal observed, remarkable hemorrhage, and bone removal, and demographic factors, such as patients’ ages and genders, were analyzed and compared. All factors are listed in Table I.

When the data were introduced into a multiple logistic regression model, the patients were divided according to the relationship of the roots to the inferior alveolar nerve (types 1 and 2 vs. types 3-5). Patient were similarly divided into 2 groups based on age (≤25 and >25 years), and into 3 groups based on the surgeons’ seniority (experience of 1-4 years, 5-9 years, and ≥10 years). Postoperative hypoesthesia of the lower lip was examined 1 month after surgery. The possibility of any impairment of labial and chin sensation was investigated. In cases of diminution of sensation, a neurologic examination assessed the degree of the deficit. Light-touch sensation was checked with pins and needles, tactile discrimination with the sharp and the blunt end of a dental probe, and pain awareness with a forceps.

Statistical analyses

Data collection and statistical analyses were carried out with SPSS 15.0 (SPSS, Chicago, IL) and StatView-J-4.5 (Abacus Concepts, Berkeley, CA) software. The association of each variable with the presence of hypoesthesia of the lower lip was tested by the Mann-Whitney U test or by 1-way analysis of variance and Fisher protected least significant difference method. A value of $P < .05$ was considered to be statistically significant. All of the variables associated with hypoesthesia of the lower lip were introduced into a multiple logistic regression model. Forward stepwise algorithms were used, with the rejection of those variables that did not fit the model significantly. Multivariate odds ratios (ORs) and 95% confidence intervals (CIs) were also calculated for the significant signs. Again, a value of $P < .05$ was considered to be statistically significant.

RESULTS

Demographic factors

There were a total of 2,528 teeth in 1,854 patients included in this study (740 male and 1,114 female). The incidence of hypoesthesia of the lower lip was 1.3% (34 out of 2,528 teeth). The patients had a mean age of 31.8 ± 10.7 years (range 16-79 years). The patients with hypoesthesia of the lower lip had a mean age of...
38.5 ± 11.0 years (range 22-60 years). The patients without hypoesthesia of the lower lip had a mean age of 31.8 ± 10.6 years (range 16-79 years). Patients with hypoesthesia of the lower lip were significantly older than those without hypoesthesia (P < .05; Table I). There were no significant differences between the genders in the patients with and without hypoesthesia (Table I).

**Procedure-related factors**

Hypoesthesia of the lower lip developed in 3 out of 496 teeth in patients treated by the surgeons with 1-4
years of experience, in 20 out of 1,007 teeth in the group treated by surgeons with 5-9 years of experience, and 11 out of 1,025 teeth in the group of patients treated by surgeons with ≥10 years of experience. The incidence of hypoesthesia after extraction by surgeons with 5-9 years of experience was the highest in the 3 groups. There was a significant difference in the incidence between patients treated by surgeons with 5-9 years and 1-4 years of experience (P < .05; Table I).

The inferior alveolar nerve was exposed in 30 out of all 2,528 teeth. Postoperative hypoesthesia developed in 6 of these 30 cases of exposure. The ratio of hypoesthesia in the extraction groups with nerve exposure was significantly higher (P < .05) than in patients without exposure (Table I).

Remarkable hemorrhage occurred during extraction of 12 of the 2,528 teeth. Postoperative hypoesthesia developed in 4 of these 12 cases. The development of hypoesthesia in the extraction groups with remarkable hemorrhage was significantly higher (P < .05) than in the cases without exposure (Table I).

**Radiographic factors**

The most common Winter classification was mesioangular (1,063 teeth), and the least common Winter classification was distoangular (134 teeth). The most frequent Pell and Gregory classification was IA, in 1,087 teeth. There were significant differences among the number of cases for each group as determined by a univariate analysis (P < .05; Table I). However, there were no significant differences indicated by the multivariate analysis.

Radiographic signs indicating loss of the white line of the root were present in 47 of the 2,528 teeth. The ratio of hypoesthesia in the extraction groups with the loss of the white line of the root was significantly higher (P < .05) than in cases without the loss (Table I).

Similarly, radiographic evidence of diversion of the canal was demonstrated for 35 of the 2,528 teeth. The ratio of hypoesthesia in the extraction groups with the diversion of the canal was significantly higher (P < .05) than in those without it (Table I).

The most common radiographic sign about the relationship of the roots to the inferior alveolar nerve was type 3, which was diagnosed in 1,254 teeth. The least common radiographic sign was type 1, which was diagnosed in 207 teeth. The ratio of hypoesthesia in the extraction groups with type 1 classification was significantly higher (P < .05) than with the other type classifications (Table I).

Applying the logistic regression model and forward stepwise algorithms, procedure-related factors during surgery, such as observation of the canal and remarkable hemorrhage, and radiographic signs, such as loss of the white line of the root, diversion of the canal, and the relationship of the roots to the inferior alveolar nerve were identified and included as significant variables (Table II). Patient gender and Winter classification were excluded from this model, because the factors were not significant by univariate analysis. The multivariate adjusted ORs and 95% CIs of the included factors were calculated. The discriminant hitting ratio (98.7%) was considered to be excellent in this study.

**DISCUSSION**

Injury to the inferior alveolar nerve is a characteristic complication following the removal of an impacted tooth.1-27 This complication often leaves the patient dissatisfied with the surgery. Predicting hypoesthesia of the lower lip before surgical intervention is a common desire of surgeons and patients. Therefore, preoperative assessment must be carried out radiologically in an attempt to identify the proximity of the impacted tooth to the inferior alveolar canal. Many investigators have reported hypoesthesia of the lower lip as associated with mandibular third molar removal.3,5,7,10,14,15,17-25 However, few studies to date evaluate the multivariate relationships among risk factors and hypoesthesia of the lower lip.21,26,27 We sought to identify 1 or more risk factors associated with postoperative hypoesthesia of the lower lip to enhance patient outcome. In the present study, we demonstrated the multivariate relationships among risk factors and hypoesthesia of the lower lip.

Other studies have reported that the incidence of postoperative hypoesthesia of the lower lip ranged from 0.4% to 8.4%.3-25 Most cases of hypoesthesia of the lower lip are temporary, and the incidence of permanent hypoesthesia is generally <1%.3,5,7,9,11,12,14,15,17 In our results, the ratio of the temporary hypoesthesia was 1.5%, and permanent hypoesthesia (>6 months) was 0.6%. These results were therefore similar to previous studies.3-25

**Table II. Multivariate logistic regression analysis of the risk factors of hypoesthesia**

<table>
<thead>
<tr>
<th>Variable</th>
<th>P value</th>
<th>Odds ratio</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remarkable hemorrhage</td>
<td>.001</td>
<td>19.77</td>
<td>7.11-58.77</td>
</tr>
<tr>
<td>Inferior alveolar nerve exposure</td>
<td>.037</td>
<td>4.55</td>
<td>9.07-59.84</td>
</tr>
<tr>
<td>Loss of the white line</td>
<td>.000</td>
<td>23.30</td>
<td>1.10-19.92</td>
</tr>
<tr>
<td>Diversion of the canal</td>
<td>.000</td>
<td>20.44</td>
<td>3.47-112.60</td>
</tr>
<tr>
<td>Close relationship of the roots to the inferior alveolar nerve (types 1 and 2)</td>
<td>.000</td>
<td>9.40</td>
<td>3.19-27.74</td>
</tr>
</tbody>
</table>

CI, Confidence interval.
Several investigators have found older age to increase the risk of inferior alveolar nerve damage, whereas others have failed to detect any correlation between age and hypoesthesia. In the present study, the patients who developed hypoesthesia of the lower lip were older than those without hypoesthesia by univariate analysis. The removal of impacted teeth from older adult patients may be more difficult than in younger patients, or the healing process could be poorer, leading to greater sensory loss. To minimize the risk of hypoesthesia, we recommend checking for the necessity of third molar surgery during adolescence.

Some investigators concluded that the highest-risk patients are female. Nakagawa et al. suggested that one of the possible reasons for this is that the thinner mandibles of female patients provide a smaller distance between the tooth and the mandibular canal, increasing the risk of nerve injury. On the other hand, there have been several reports that have concluded that there is no connection between gender and hypoesthesia, or that female subjects have a lower risk of hypoesthesia. In the present study, there was no significant correlation between age and gender of the patients and hypoesthesia by multivariate analysis. We speculated that hypoesthesia had a stronger relationship with procedure-related and radiographic factors than with demographic factors.

It has also been reported that there is a higher rate of inferior alveolar nerve damage in patients treated by less experienced surgeons. However, other reports have failed to confirm this. In the present results, the incidence of hypoesthesia after extraction by surgeons with 5-9 years of experience was significantly higher than that by surgeons with 1-4 years of experience. However, there was no significant correlation between the seniority of the surgeons and the incidence of hypoesthesia in the patients by multivariate analysis.

The exposure of the inferior alveolar nerve and the incidence of remarkable hemorrhage during extraction were both noted to be associated with an increase in inferior alveolar nerve damage, not only in the present report, but also in other reports. Gülicher et al. reported that postoperative hypoesthesia of the lower lip occurred nearly 5 times more frequently in cases where there was nerve exposure during extraction. It has been demonstrated that bleeding can result from disruption of the inferior alveolar nerve, indirect damage due to compression from postoperative swelling, or hemorrhage. Our results were similar to these earlier reports. In the present study, the exposure of the inferior nerve and the presence of remarkable hemorrhage during extraction were associated with a higher risk of hypoesthesia. In addition, the development of remarkable hemorrhage (OR 19.76) was associated with a higher risk of hypoesthesia by multivariate analysis than was alveolar nerve exposure (OR 4.56). However, it is unclear whether hemorrhage is merely a consequence of disruption of the inferior alveolar nerve bundle or whether it has some other source and actually represents the cause of inferior alveolar nerve damage resulting from compression.

Many investigators have reported a correlation between the anatomic position, including Winter classification, and hypoesthesia of the lower lip. This remains controversial, because other investigators have found no evidence of an impact of the position. However, few studies evaluated the multivariate relationships among risk factors and hypoesthesia of the lower lip. In the present study, we did not find any significant correlation between the Winter classification or Pell and Gregory classification and hypoesthesia by multivariate analysis. However, the more deeply impacted teeth did have a higher risk of hypoesthesia by a univariate analysis, similar to our study. It is possible that surgical removal of these deeply impacted teeth may require more extensive manipulation and removal of bone close to the inferior nerve, increasing the postoperative inflammation and the risk of both direct and indirect damage to the nerve. We speculate that although the absolute anatomic position of the third molar is not a significant risk factor, the distance between the root and the nerve is a major risk factor for postoperative hypoesthesia. In addition, the anatomic relationship between the inferior alveolar nerve and the roots of the third molar teeth has been shown to help predict the likelihood of nerve injury.

Based on these findings, we investigated the relationship of the roots to the inferior alveolar nerve radiographically according to the methods proposed by Tanaka et al. The close relationship of the roots to the inferior alveolar nerve, such as is present in type 1 and 2 cases, was associated with a significantly high risk (OR 9.40) of hypoesthesia. In addition, loss of the white line of the root (OR 23.30) and diversion of the canal (OR 20.44) were significantly higher risk factors for hypoesthesia, similarly to other reports. As mentioned above, it is speculated that the distance between the roots and the nerve is a major factor predicting inferior nerve damage. Therefore, computerized tomography (CT) should become a standard to disclose the anatomic relationship of the roots to the inferior alveolar nerve if the tooth surrounds the nerve. Indeed, the efficacy of such a method was indicated by a previous study. However, considering the high cost of CT scans and the amount of radiation used for CT,
the use of panoramic radiography is justified in planning surgery for impacted teeth. Regardless of the situation, the surgeon must inform the patient about the various options and risks of complications before surgery so that the patient can make an informed decision as to whether to undergo surgery. In addition, the surgeon must consider other methods to avoid inferior alveolar nerve damage whenever it is possible.\textsuperscript{32,33}

In conclusion, we successfully demonstrated the multivariate relationships among various risk factors and hypoesthesia of the lower lip. Procedure-related factors during surgery, such as observation of the canal and remarkable hemorrhage, and radiographic signs, such as loss of the white line of the root, diversion of the canal, and close distance between the roots and the inferior alveolar nerve, were identified and included as significant variables. These results revealed that these factors were associated with a high risk of hypoesthesia of the lower lip after extraction. We believe our findings will contribute to the successful surgical treatment of patients with impacted third molars in the fields of dentistry and oral surgery.

REFERENCES

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