Low risk of neurosensory dysfunction after mandibular third molar surgery in patients less than 30 years of age. A prospective study following removal of 1220 mandibular third molars

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Objective. The study aims were to estimate the prevalence of neurosensory dysfunction (NSD) and identify risk factors for NSD after mandibular third molar (M3) removal.

Study design. In this prospective cohort study 864 patients had their M3 removed. Age, gender, surgeon’s experience, and radiographic findings were recorded and the outcome variables were NSD and data analyses.

Results. In 884 patients, 1220 M3 were removed. Fourteen patients reported NSD postoperatively; 10 inferior alveolar nerve (IAN) injury, 3 lingual nerve (LN) and 1 had injury to both. After 5 years the number of patients with NSD of the IAN had decreased to 5, but no change in the LN.

Conclusion. Age and cortical line interruption were significantly associated with the risk of developing sensory dysfunction. All patients younger than 30, and 3 of 8 patients older than 30, had full recovery of the IAN injury. NSD of the LN persisted in all patients. (Oral Surg Oral Med Oral Pathol Oral Radiol 2013;116:411-417)

Removal of impacted or erupted third molars is one of the most frequently performed dentoalveolar surgical procedures, and it is associated with various post-operative sequelae. Many studies describe unwanted complications such as paresthesia or anesthesia of the inferior alveolar nerve (IAN) or lingual nerve (LN). There are well-established indications for removal of impacted third molars, and controversies about prophylactic removal of asymptomatic mandibular third molars are based on evaluating costs and risks of removal against the consequences of non-removal. Data on the frequency of severe complications in the management of asymptomatic, impacted mandibular wisdom teeth are lacking. Prophylactic removal of impacted third molars is widely practiced, especially in Europe and the United States, and it is estimated that 18%-51% of the population endure this procedure. Reasons for prophylactic surgery include the need to minimize the risk of disease (cysts and tumors), reduction of the risk of mandibular angle fracture, increased difficulty of surgery with age, and that third molars may be of less importance for mastication. The therapeutic indications for removal of mandibular third molars have been established as recurrent pericoronitis, cyst development and unrestorable caries or periodontal disease.

Previous studies have shown that IAN and LN paresthesia occur widely, from 0.4% to 8.4% and none to 23.0% of cases, respectively. Permanent dysesthesia of the IAN persisted in 0.91%, and of the LN in 0.37% of patients. Most trigeminal nerve injuries undergo spontaneous recovery; 96% of IAN and 87% of LN injuries recover within 4-8 weeks after surgery, and the recovery rates are not influenced by gender, and only slightly by age.

Some injuries may be permanent, lasting longer than 1 year, with varying outcomes, ranging from mild hypesthesis to complete anesthesia and neuropathic responses resulting in chronic pain. This depends on the type of injury (i.e., stretch, crush, section) and the presence of severe inflammation. Following injury, the nerve will remain in position and regenerate in a relatively short time unless displaced into the socket. Thus, after injury to the IAN, good recovery is generally expected but the more proximal lesions have worse prognoses.

The most common cause of IAN and LN injury is traumatic third molar surgery, shown to account for 52% of injuries, and risk factors included the patient’s age (more than 30 years), horizontally impacted teeth, close radiographic proximity to the inferior alveolar canal (IAC) and treatment by inexperienced graduate or postgraduate students.

Statement of Clinical Relevance

Inferior nerve damage may appear after 3rd molar surgery. This present investigation shows that nerve damage is infrequent and often temporary in patients less than 30 years of age. In older patients, nerve damage seems to be more permanent.
Because of the different anatomic positions of the LN, the surgeon is often not able to identify its location pre-operatively. Studies have described the position of the LN using dissections of cadavers to be above the lingual crest in 10% of the cases and, using ultrasound, the distance of the LN from the alveolar cortex was measured to be 1 mm on average.

To strengthen observational studies like examination of injuries of nerves after operations, one should follow the STROBE Statement in preparing patients-oriented manuscripts.

The purpose of this study was to estimate the prevalence of neurosensory dysfunction (NSD) and identify risk factors for NSD after mandibular third molar (M3) removal. The investigators hypothesize that the prevalence of NSD in our study is comparable with other studies and that NSD is not related to gender and age of the patient. The specific aims of the study were to assess the outcome of IAN and LN injury up to 5 years after surgery and to determine the prevalence, risk factors and prognosis of NSD after surgery of the M3.

### MATERIAL AND METHODS

#### Study design

To address the research purpose, the investigators designed and implemented this nonrandomized prospective clinical study of nerve injuries after removal of mandibular third molars. The study population was composed of all patients older than 18 years, presenting for surgical removal of their M3 between January 1, 2007 and December 31, 2008. To be included in the study sample, patients had to be seen 1 week after surgery for routine follow-up and reviewed for possible nerve injury of the LN or IAN. Patients, who had altered sensation in the distribution of the IAN or LN, were followed for up to 5 years. Patients were excluded as study subjects if they refused to take part in the study or if they were unwilling to come for postoperative evaluation 1 week after surgery. The Regional Medical Ethical Committee, East, Norway (1.2007.1293) approved the study.

#### Study variables

For each patient, several demographic variables were recorded including age, gender, side of operation, surgeon’s experience, indications and radiographic findings on orthopantomograms (OPG) (Table I). Information about the operator was registered: specialist in oral surgery, postgraduate or undergraduate student and duration of operation, relation between the mandibular canal and the removed tooth and complications during or after the intervention. At the same visit, the patients were given written information about the study and signed informed consent forms.

The primary outcome variable was nerve injury (y/n) to the IAN and/or LN immediately after the surgery and at follow-up up to 5 years. Indications for surgical removal of lower third molars were based on the recommendation of the Norwegian Center for the Evaluation of Medical Methods and clinical experience. The secondary outcome variable was a vertical visual analog scale (VAS) from 0 to 100, where 0 indicated “no pain sensation” or “improved taste” and 100 indicated “pain cannot be worse,” “no sensation,” or “decreased taste.” The characteristics of the patients with nerve injury are presented in Table I. The molars were extracted or removed surgically. Local anesthesia (2% Xylocain with 12.5 µg/mL; AstraZeneca UK Limited, Luton, UK) was always used as local tissue infiltration or IAN regional block. Patients less than 16 years of age were excluded from the study.

#### Data collection methods

All patients who experienced IAN and LN injury were interviewed and examined according to a standardized test method recording subjective and objective neurosensory functions and registered by the same operator. The same procedure was performed 3-4, 6- and 12-months and up to 5 years postoperatively. For each visit, the patients described subjective and objective changes in sensation.

Subjective evaluation was performed by the patients to describe sensation and function of the injured area. Each patient was asked a series of standard questions: whether the affected area gave rise to problems like altered sensation, pain, tingling and problems associated with eating, drinking and chewing, speech, appearance, or interference with daily activities.

In this study, we used 3 different mechanoceptive objective testing methods to evaluate the perioral mechanoeceptive skin receptor function that responds to light touch (LT) sensation of the mucosa and the skin. The Semmes Weinstein monofilaments, von Frey hair, LT (North Coast Medical, San Jose, CA, USA), were used to evaluate the threshold of the slowly adapting fiber/receptor system. We used a monofilament placed perpendicularly to the skin with a pressure of 20 mN (2 g) in the actual area. At this force, the filaments start to bend.

Measurements of 2-points discrimination were performed with the MacKinnon-Dellon Disk-Criminator (North Coast Medical, San Jose, CA, USA) with distances of 5, 10, and 15 mm between the blunt probes. Each probe was 0.8 mm in diameter. The instrument was moved carefully vertically downward over the skin. The minimum separation that was consistently reported as 2 points was recorded as the discrimination threshold.

Sharp and dull discrimination was assessed with the sharp and a dull end of a probe which gently touched...
the area to be examined with minimal pressure up to 15 g. Responses in 7 of 10 points or more were classified as positive ("yes") and responses in 6 or fewer of 10 points were classified as negative ("no").

Intraoral examination of altered sensation was performed with palpation of the mucosa and registered if this evoked any sensation in the affected lip or chin.

As a control group, 138 patients were randomly selected. Their mandibular third molars had been removed during the same time period.

Data analyses
The data were processed using the SPSS version 17.0 (IBM Corp., Armonk, NY). The following procedure was applied for replacing missing data among the patients with nerve injury:

1. When the 12 months value was missing, the 6 months result was used as 12 months value.
2. When the 6 months value was missing, the 3 months value was used as 6 months value.

When comparing proportions in the nerve injury group and the control group, Chi-square was used. When comparing mean age, a 2-sided independent samples t test was used. A significance level of 5% was used throughout the study.

RESULTS
The material comprised 1220 lower third molars that were removed from 864 patients at the Department of Oral Surgery and Oral Medicine, University of Oslo, in the 2-year period 2007 and 2008, where 477 patients (55.2%) were under 30 years of age and 387 (44.8%) were 30 years and older. Of the total of 1220 third molars removed, 917 were removed by postgraduate students in the oral surgery service. The characteristics of the patients are presented in Tables I and II.

Among these patients, fourteen reported hypesthesia, anesthesia, paresthesia or dysesthesia postoperatively, 10 with injury to the IAN alone (0.8%), 3 with injury to the LN only (0.2%), and 1 patient experienced injury to both nerves (0.1%). The number of patients with IAN injury decreased to 5 (0.4%) after 5 years of follow-up, but alteration of the LNs was unchanged at 5 years follow-up. The patient with injury to both nerves experienced normal sensation of the IAN after 4 weeks, but the LN sensation was nearly unchanged after 5 years.

The mean age of the patients at the time of operation was 28.1 years, range 18-86 years and 450 (52.1%) were women. Nerve injuries after removal of the mandibular third molars were significantly related to

<table>
<thead>
<tr>
<th>Gender and age</th>
<th>Nerve injury (1/2)</th>
<th>Operating side (L/R)</th>
<th>Operator (1/2/3)</th>
<th>Panoramic radiographic signs (y/n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>F 23</td>
<td>2</td>
<td>L</td>
<td>2</td>
<td>y</td>
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<tr>
<td>F 25</td>
<td>2</td>
<td>R</td>
<td>3</td>
<td>n</td>
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<tr>
<td>F 27</td>
<td>1</td>
<td>R</td>
<td>2</td>
<td>y</td>
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<tr>
<td>F 29</td>
<td>1</td>
<td>L</td>
<td>2</td>
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<td>F 31</td>
<td>1, 2</td>
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<tr>
<td>M 59</td>
<td>1</td>
<td>L</td>
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<td>y</td>
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</tbody>
</table>

Nerve injury: IAN, inferior alveolar nerve (1); LN, lingual nerve (2); IAN and LN (1, 2). Operating side: L, left; R, right. Operator: specialist (1), postgraduate student (2), undergraduate student (3). Panoramic radiographic signs: y, yes; n, no.

Table I. Objective characteristics of the patients treated with removal of the lower third molar and the patients with postoperative nerve injury

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Nerve injury</th>
<th>Control group</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. (n)</td>
<td>14</td>
<td>138</td>
<td></td>
</tr>
<tr>
<td>Gender (male)</td>
<td>4 (28.1%)</td>
<td>72 (52.5%)</td>
<td>.092</td>
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<tr>
<td>Age (years)</td>
<td>Mean: 38.6</td>
<td>Mean: 27.0</td>
<td>.007</td>
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<td></td>
<td>SD: 13.3</td>
<td>SD: 8.1</td>
<td></td>
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<tr>
<td>Interruption of cortical line (n)</td>
<td>11 (78.1%)</td>
<td>43 (31.7%)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Diversion of the canal (n)</td>
<td>6 (42.9%)</td>
<td>64 (41.4%)</td>
<td>.80</td>
</tr>
<tr>
<td>Darkening of root (n)</td>
<td>7 (50.0%)</td>
<td>40 (29.0%)</td>
<td>.11</td>
</tr>
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</table>

Table II. Characteristics of the patients with nerve injury, the control group and the panoramic radiographic risk factors
They themselves to their injury and accepted it. The result after 1 year. Most of the patients had accustomed a 45.7% improvement after 5 years compared with the VAS registration. The average VAS score showed the nation gave less NSD compared with the subjective evaluation. In one of the patients the objective evaluation showed that many of the patients had improved compared with the 1 year follow-up, except for 1 person who felt dysesthesia in the tongue. The reason for this injury was an accidental incision (Table III).

The results from the questionnaire regarding subjective evaluation showed that many of the patients had only minor degree of hypesthesia, mild paresthesia or anesthesia 1 year postoperatively. At the final examination 4-5 years postoperatively, all the injured patients had improved compared with the 1 year follow-up, except for 1 person who felt dysesthesia in the tongue. The reason for this injury was an accidental incision (Table III). Taste ability and pain were significantly associated with NSD (P = .004).

At the end of data collection, 5 years postoperatively, 7 of 9 patients with NSD showed up for the final evaluation. In one of the patients the objective examination gave less NSD compared with the subjective VAS registration. The average VAS score showed a 45.7% improvement after 5 years compared with the result after 1 year. Most of the patients had accustomed themselves to their injury and accepted it.

DISCUSSION
The purpose of this study was to estimate the prevalence of NSD and identify risk factors for NSD after mandibular third molar (M3) removal. We hypothesized that the prevalence of NSD in our study was comparable with other studies and that NSD is not related to gender and age of the patient. The specific aims were to assess the outcome of IAN and LN injury up to 5 years after surgery and to determine the prevalence, risk factors and prognosis of NSD after surgery of the M3.

The results of our study showed that after 3-4 months, all patients aged 29 years or younger had recovered fully after damage to the IAN, but only 3 of 8 patients older than 30 years had full subjective recovery of the IAN after 5 years. In our study, we followed the patients with sensory disturbance for up to 5 years. After 6 months, recovery seemed to be slight.

Our results may confirm that permanent IAN dysfunction are more frequent after M3 removal in patients older than 30 years and that LN dysfunction may be permanent in all age groups. This result may help the surgeon in the decision making before removal of M3 in different age groups.

In this prospective study, the average complication rate for permanent nerve injury was 0.7%, (5 patients with IAN and 4 patients with LN). This is in agreement with other reports.21

Patients’ age (P < .007) at the time of surgery and one of the radiographic findings (P < .001) were significantly associated with the neurosensory outcome. The influence of the patient’s age on the prevalence of injury to the IAN is disputed. Several investigators have demonstrated significant findings,22 whereas others have not.23 In our study, there was a significant relationship between the patient’s age and diminution of labial and lingual sensation. A clinical study demonstrated that germectomy is associated with lower incidence of this complication than is delayed extraction,24,25 and older patients had a higher occurrence of IAN injury.9 The removal of impacted teeth from adult patients was found to be more difficult and led to sensory loss more often than in the younger people. The age-related trend has been noted by most other authors. Factors that have been suggested to explain this situation are increased bone density, surgical difficulty, complete formation of the root and reduced capacity for subsequent healing.2 Some do not support age as a risk factor,26 but rather believed the experience of the surgeon to be a determining factor.

It has been suggested that experience of the surgeon is closely related to the postoperative complication rate,1 although other studies have failed to show any relationship.27 In our study, the operators responsible for these 14 injuries were 1 specialist, 11 postgraduate students and 2 undergraduate students (Table I), and the undergraduate students caused 2 injuries of the LN. Additional evidence supporting a close relationship between LN damage and surgical technique is the fact that this complication is more frequent with less experienced surgeons.6 Most of the injured patients in our study were women. This is in agreement with previous studies.12 Currently, the panoramic radiograph is the imaging technique of choice to evaluate this anatomical intimacy and thereby the surgical risk factors associated with third molar extraction.17 A significant relationship exists between this radiological sign and the impairment of labial sensation in terms of interruption of the cortical line, darkening of the root, diversion of the canal.
deflected root, and narrowing of the root. Of these, the three first radiological signs have been considered to be more frequently associated with IAN injury. In our study, only interruption of the cortical line was significantly associated ($P = .001$) with IAN injury. In the presence of such radiological findings, the indications for third molar removal should be critically revised, and the patient should be informed of possible risks. In our group of patients with permanent nerve injury, all had their third molar removed because of therapeutic indications. We analyzed the vertical impaction and position of the third molar only in relation to the mandibular canal.

After 3-4 months, all patients aged 29 years or younger had recovered fully after damage to the IAN, and refused to come for further follow-ups. Three of the 8 patients older than 30 years had full subjective recovery of the IAN after 1-17 months. In our study, we followed the patients with sensory disturbance for up to 5 years. After 6 months, recovery seemed to be slight. In other studies, alterations of sensation persist longer than 6 months after injury are considered to be permanent. Recovery after 9 months from the time of surgery is rare, and it is unlikely that any recovery will occur after 18 months to 2 years of follow-up. In the IAN, the degree of persistent deficit was slight and, in most instances, did not affect the patients too much, whereas the permanent alterations of the LN were more discernible for the patients. Some studies have reported a lower recovery proportion for the LN compared with the IAN, in agreement with our observations, where little improvement was seen in tongue sensation from first to the twelfth month and up to 5 years, though other studies have failed to support this.

Various aspects of symptoms and function were recorded by the VAS. The patients with injury felt subjectively different degrees of improvement. At present, there is no "purely" objective testing modality available for evaluation of iatrogenic injury to the terminal branches of the trigeminal nerve, and this makes the clinical diagnosis and management of these conditions fairly complicated for the surgeon. In our study, the objective test methods often supported the subjective findings.

Differences in sensory loss within the distribution of the injured nerve were observed in our study.
Nerve injuries differ in severity and thus it is important to differentiate injuries uniformly to monitor recovery. We checked only the A-β and Aδ fibers and registration of light tactile touch. Research shows that the best method to demonstrate persisting abnormality is locating the way the patient can localize the position of 1 stimulus. It is unclear to what extent these test methods are reproducible. But these high-quality testing and grading methods are seldom used, possibly because they are quite time consuming.

The Semmes-Weinstein monofilament, LT test is known to be reproducible but time-consuming. Sharp and dull discrimination is a difficult-to-standardize test, mainly because of the variability of the applied pressure.

Our study involved a greater number of patients with a wide age range and we followed the patients for up to 5 years. The estimate of IAN and LN damage in different age groups may be of value in decision making before M3 surgery. However, we measured objective and subjective nerve dysfunction and not Functional Sensory Return as reported by others. Interpretation of our results may therefore be difficult in comparison with others.33, 34

In conclusion, our findings suggest that damage of the IAN or LN is a rare complication. Injury to IAN has a good likelihood of regenerating over time and most of the injuries healed after 3-4 months. This study indicated that IAN regeneration was generally more rapid and complete in patients less than 30 years of age. The goal for further studies will be to standardize the methods of examination for trigeminal nerve dysfunction after M3 surgery and to establish a set of prognostic factors for the risk of nerve dysfunction and recovery after M3 surgery.

REFERENCES
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