**Anatomy of impacted lower third molars evaluated by computerized tomography: is there an indication for 3-dimensional imaging?**

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**Objective.** Surgical removal of impacted third molar is one of the most frequent procedures in oral surgery. Today 3-dimensional (3D) imaging is occasionally used. The aim of this study was to describe and estimate the frequencies of anatomic variations of lower third molars in patients with panoramic findings at high risk for inferior alveolar nerve (IAN) injury.

**Study design.** The investigators designed and implemented a retrospective cases series study with a study population composed of patients presenting with an impacted lower third molar with projection of the tooth over the full width of the IAN in panoramic radiograph and, therefore, 3D imaging before a planned surgical removal. Spatial relationship to the IAN, type of angulation, root configuration and maturation were primary study variables. Descriptive statistics were computed for all variables.

**Results.** A total of 707 wisdom teeth in 472 patients (54% female, 46% male) were evaluated. A close relationship to the IAN was seen in 69.7%, and in 45.1% the diameter of the mandibular canal was reduced. In 52.8% the IAN was vestibular and in 37.3% lingual to the roots; there were 9.9% with an inter- or intraroot course. Most teeth had 1 or 2 roots (86.7%), but 13.3% had ≥3 roots. Mesial angulation was the main type (40.2%), followed by vertical (29%), horizontal (13.9%), distal (10.2%), and transverse (6.8%) positions.

**Conclusion.** Based on the range of variations in the course of the nerve and the number of roots the authors recommend 3D imaging before surgical removal of a lower third molar that shows signs of a close relationship to the IAN. (Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2011;111:547-550)

Surgical removal of impacted third molars is a regular, maybe even the most frequent, procedure in oral and maxillofacial surgery. Damage to the inferior alveolar nerve (IAN) is a complication of the procedure. The age of the patient, inexperience of the surgeon, and deep impaction have been described as possible causes.

Since the development of computerized tomography (CT) in 1972, 3-dimensional (3D) imaging has become ever more routine, including before wisdom teeth removal. Several authors have described radiologic signs that indicate a close relationship between the lower third molar and the IAN in conventional as well as in 3D radiography. Particularly, in situations with classic risk signs noted in panoramic imaging, as enumerated by Rood, the knowledge of the exact 3D anatomy of the patient might be useful not only for risk evaluation and informed consent, but also for adaptation of the surgical strategy.

Using 3D imaging, the aim of the present study was to describe and estimate the frequencies of anatomic variations of lower third molars in patients with panoramic findings at high risk for IAN injury after surgical removal of the tooth. Special focus was applied to the lower third molar’s relationship to the IAN.

**METHODS**

To address the research purpose, the investigators designed and implemented a retrospective cases series study. The study population was composed of all patients presenting to the Clinic for Oral and Maxillofacial Surgery at the University of Zurich, Switzerland,
for evaluation and management of third molars between April 1994 to September 2006. To be included in the study sample, patients had to have an impacted lower third molar with projection of the tooth over the full width of the IAN in panoramic radiograph and, therefore, 3D imaging prior to a planned surgical removal. Patients were excluded as study subjects if they had other pathologies or previous surgery in the region or if CT quality was poor and safe evaluation of the criteria to be examined was therefore impossible.

The following criteria were the primary study variables:

Spatial relationship between tooth and IAN:
- IAN lateral
- IAN lingual
  - Without perforation of cortical plate
  - With perforation of cortical plate
- IAN between apically open roots (inter-root IAN course)
- IAN inside apically closed roots (intra-root IAN course)

Distance from IAN to tooth: direct contact versus cancellous bone in between
Diameter of IAN canal: constant diameter versus obvious reduction of diameter
Maturation: fully formed roots versus immature roots
Type of retention according to Wolf and Haunfelder:
- Vertical
- Horizontal
- Distal
- Transversal

Gender and side of the teeth were also evaluated to ensure a homogeneous group.

Descriptive statistics were computed for each study variable by using Excel 2003/SP3 (Microsoft Corp., Redmond, WA, USA).

RESULTS
In total, 474 patients with 707 wisdom teeth fulfilled the inclusion criteria of the study. No patient or tooth was excluded due to poor CT quality.

The female-to-male ratio was 255 (54.0%) to 217 (46.0%) for patients, and 392 (55.4%) to 315 (44.6%) for the teeth. The left-to-right ratio was 364 (51.5%) to 343 (48.5%).

Spatial relationship to IAN
In 493 teeth (69.7%), there was a direct contact between the structures of the lower third molar and the IAN, without any cancellous bone in between. In 64.7% of these teeth (319, 45.1% of overall group), there was a narrowing of the IAN at the contact area (Fig. 1).

Three hundred seventy-three teeth (52.8%) had a buccal IAN course and 264 (37.3%) a lingual IAN course; 58 (8.2%) of the teeth had at least 1 root on each side of the IAN (inter-root course), and in 12 teeth (1.7%) the IAN went through a root configuration that was fused below the IAN, a situation known as an intraroot course of the IAN. Regarding the lingual
course, there was a perforated cortical plate in 11.7% (31, 4.4% of overall group).

Root configuration
There were fully developed roots in 610 (86.3%) of the examined teeth. Most of the lower third molars had 2 roots (569, 80.5%), followed by 3 roots (83, 11.7%) and a single root (44, 6.2%). In only 11 teeth (1.6%) were there 4 roots. No lower third molars were found with >4 roots.

Type of retention
Most of the teeth were mesially angulated (40.2%, 284) or vertically retained (29%, 205); 13.9% (98) were in a horizontal position, and 10.2% (72) were distally angulated. The rarest position was the transverse at 6.8% (48). An overview of the evaluated anatomic data is presented in Table I.

DISCUSSION
The aim of the study was to describe and estimate the frequencies of anatomic variations of lower third molars in patients with panoramic findings of high risk for IAN injury. It can safely be concluded that there is no configuration that represents a vast majority of lower third molars in the selected sample. The IAN course was vestibular in 52.8%, but lingual in 37.3%. In almost 10%, the course was inter- or intraroot. Root configuration was more stable, with ~80% following the classic 2-root anatomy, but >10% had 3 or 4 roots. Root angulation and maturation was also quite variable. However, the clinical impact was less, because plain radiograph would always reveal these points.

The high numbers (70%) with a close relationship to the IAN and 45% with reduced IAN canal diameter suggest that 2D imaging was capable of predicting a close relationship, and these results agree with those from other studies.13,14

This study confirms that 47.2% did not follow the vestibular IAN course. It also shows that in quite a number of patients (9.9%), the IAN was to be expected between the roots of the lower third molar. Both results generally match those of different studies with more or less similar inclusion criteria.11,13-15 These numbers are correct only for the subgroup of lower third molars with 2D risk signs, according to Rood and Shehab,8 but this is the relevant subgroup in matters of IAN impairment after surgery.

Regarding the root configuration, >10% of the teeth had 3 or 4 roots, which may be difficult to evaluate with conventional radiography owing to the superposition of 2 of them.16 Interestingly, despite the strict inclusion criteria that would suggest fully developed roots, almost 15% of the teeth did not have fully developed roots.

The great majority of impacted lower third molars showed a mesial or vertical retention type. This is different from the results of, e.g., Tantanapornkul et al.,11 who saw 48% horizontal-positioned teeth in a smaller group of 80 teeth, but it is similar to the findings in most other studies.17-21 However, as with root development status, retention type can easily be identified by conventional radiography22 and should therefore not be particularly relevant for clinical purposes.

A weakness of the present study is the retrospective character, which is not always very satisfying and because of which we cannot rule out that patients were missed that should have been included. But we think this weakness was offset by the high number of evaluated teeth. The results should therefore be representative.

For clinical work, we strongly recommend additional 3D imaging for the subset of patients that show the risk factors outlined by Rood and Shehab7 and are assessed as elevated risk.1,17 This recommendation is based on the variety and frequency of the anatomic variations of the inferior third molars in the present study and in the literature.11,13-15 In particular, the information of the

Table I. Overview of evaluated anatomy

<table>
<thead>
<tr>
<th>Relative frequency (%)</th>
<th>Absolute frequency (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total no. of patients</td>
<td>100.0</td>
</tr>
<tr>
<td>Female</td>
<td>54.0</td>
</tr>
<tr>
<td>Male</td>
<td>46.0</td>
</tr>
<tr>
<td>Total no. of teeth</td>
<td>100.0</td>
</tr>
<tr>
<td>Female</td>
<td>55.4</td>
</tr>
<tr>
<td>Male</td>
<td>44.6</td>
</tr>
<tr>
<td>Left side (#38)</td>
<td>51.5</td>
</tr>
<tr>
<td>Right side (#48)</td>
<td>48.5</td>
</tr>
<tr>
<td>Direct contact of IAN and root</td>
<td>69.7</td>
</tr>
<tr>
<td>Narrowing of IAN canal</td>
<td>45.1</td>
</tr>
<tr>
<td>Buccal IAN course</td>
<td>52.8</td>
</tr>
<tr>
<td>Lingual IAN course (overall)</td>
<td>37.3</td>
</tr>
<tr>
<td>With complete cortical plate</td>
<td>33.0</td>
</tr>
<tr>
<td>With perforated cortical plate</td>
<td>4.4</td>
</tr>
<tr>
<td>Interroot IAN course</td>
<td>8.2</td>
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<tr>
<td>Intraroot IAN course</td>
<td>1.7</td>
</tr>
<tr>
<td>Maturation</td>
<td></td>
</tr>
<tr>
<td>Fully developed roots</td>
<td>86.3</td>
</tr>
<tr>
<td>Not fully developed roots</td>
<td>13.7</td>
</tr>
<tr>
<td>No. of roots</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>6.2</td>
</tr>
<tr>
<td>2</td>
<td>80.5</td>
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<tr>
<td>3</td>
<td>11.7</td>
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<tr>
<td>4</td>
<td>1.6</td>
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<tr>
<td>Type of retention</td>
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</tr>
<tr>
<td>Mesial</td>
<td>40.2</td>
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<td>Vertical</td>
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<td>Horizontal</td>
<td>13.9</td>
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<tr>
<td>Distal</td>
<td>10.2</td>
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<tr>
<td>Transversal</td>
<td>6.8</td>
</tr>
</tbody>
</table>

IAN, Inferior alveolar nerve.
perforation of the lingual plate is supposed to be helpful in assessing the risks of lingual nerve impairment and root dislocation.\textsuperscript{11,23,24} However, we concur with other authors who say that 3D imaging should not be a routine modality for third molar extractions.\textsuperscript{1,13,25}

In agreement with Dodson,\textsuperscript{1,26} we believe that further investigation should focus on the question of whether presurgical 3D imaging of lower third molars has an impact on the surgical morbidity and for which subgroups this applies. Objective risk factors may thereby be identified.

**CONCLUSION**

Based on the range of variations in the course of the nerve and the number of roots, the authors recommend 3D imaging before surgical removal of lower third molars that show signs of a close relationship to the IAN.

Further studies are necessary, not only to evaluate the significance of anatomic variations to the surgical outcome, but also to check whether or not this outcome can be influenced by presurgical 3D imaging.

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**REFERENCES**


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