

Original Article

Prediction of inferior alveolar nerve injury in complicated mandibular wisdom teeth extractions: a new classification system

Zhou-Xi Ye¹, Chi Yang¹, Ahmed Abdelrehem²

¹Department of Oral and Maxillofacial Surgery, Shanghai Ninth People's Hospital, School of Medicine, Shanghai Jiao Tong University, and Shanghai Key Laboratory of Stomatology, Shanghai, China; ²Department of Cranio-maxillofacial and Plastic Surgery, Faculty of Dentistry, Alexandria University, Alexandria, Egypt

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Abstract: Purpose: To introduce and validate a new classification system for the inferior alveolar nerve (IAN) injury based on the proximity and positional relation between the tooth root and the inferior alveolar canal (IAC). Methods: In this retrospective study, consecutive patients, who underwent piezosurgery extractions of complicated impacted mandibular third molars from March to November 2014, were reviewed. Only teeth in close proximity to the IAC in orthopantomogram (OPG) were included. Then, teeth were classified according to the proximity of the root to the IAC (grade I: contacting; grade II: compressing; and grade III: penetrating) in both OPG and Cone-beam CT (CBCT), as well as, the relation to the IAC (class I: on the lingual side; class II: above the IAC; class III: on the buccal side; and class IV: roots surrounding the IAC) in CBCT. The incidence of the IAN injury in all patients was recorded. χ^2 test and Fisher test was used to analyze the data. Results: 92 teeth (84 patients) in close proximity to the IAC were extracted and recorded. Of these, 33.70%, 28.26% and 38.04% were in grades I, II, and III, respectively, based on OPG; while, 36.95%, 33.70% and 29.35% were in grades I, II, and III, respectively, based on CBCT. Furthermore, the percentages of teeth in classes I, II, III and IV were 31.52%, 55.43%, 11.96%, and 1.09%. 7.61% of all the extractions led to the IAN injury. There was a positive correlation between the degree of root proximity to the IAC and IAN injury ($P < 0.05$) with the highest incidence being in class III ($P < 0.05$). Conclusion: The novel classification system seems well reproducible, facilitating the recognition of patients with higher risk of IAN injury during extraction of complicated lower wisdom teeth.

Keywords: Inferior alveolar nerve, inferior alveolar canal, complicated impacted mandibular third molar, risk classification

Introduction

Inferior alveolar nerve (IAN) injury is a well-known complication of wisdom teeth extractions, causing dysesthesia or paresthesia in 0.4% to 22% [1-3] (permanent injury ranges from 0.4% to 13.4%) of cases. Close relation between the tooth root and the inferior alveolar canal (IAC) [1, 4] is the main risk factor in IAN injury. Other factors include patient age, surgical technique, in addition to surgeon expertise [5-7].

Therefore, the analysis of the proximity and positional relation between the tooth root and the IAC is crucial in order to minimize the incidence of this complication. We have reported in a previous study, the correlation between the positional relation of the impacted third man-

dibular molar to the IAC and the IAN injury, with the latter being highest when the tooth lies buccal to the IAC [8].

Here in, we present a new classification system and a comprehensive evaluation that combines the proximity and positional relation between the tooth root and the IAC, which to the best of our knowledge has not been previously reported in the literature.

Materials and methods

Subjects and study samples

This study followed the Declaration of Helsinki on medical protocol and ethics and the regional Ethical Review Board of Shanghai Ninth People's Hospital approved the study.

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Figure 1. Classification of mandibular third molars based on the proximity between root and IAC. A. Grade I: 48 contacted IAC, wall of IAC could be identified; B. Grade II: 48 compressed IAC, wall of IAC could not be identified; C. Grade III: 38 penetrated IAC; D, E. OPG suggested that 38 penetrated IAC, while CBCT showed it contacting IAC.

We retrospectively reviewed a consecutive group of patients who had piezosurgery extraction of complicated mandibular third molars by the same surgeon, from March to November 2014. Only teeth in close proximity to the inferior alveolar canal (IAC) in orthopantomogram (OPG) were included. The complicated mandibular third molars refer to those which met at least one of the following criteria [9]: (1) partially or fully impacted; (2) contact or interrupt the inferior alveolar canal; (3) occupy more than half of the overall bony thickness of the mandible; (4) root hypertrophy or with an obvious curve; (5) considerable obstruction of the adjacent tooth during teeth extraction.

Methods

The new classification system was established based on: (1) the proximity of the tooth root to the IAC (Grades) in OPG and the coronal reconstructions of the CBCT (**Figure 1**); (2) the positional relation to the IAC (Classes) in the coronal reconstructions of the CBCT (**Figure 2**).

Data management and analysis

All OPG and CBCT images were evaluated twice by the same investigator (YE ZX) on the same computer with Centricity RIS/PACS CE (GE Healthcare), with an interval of at least 1 week. The images were randomly disordered before the second evaluation. If a consensus between both evaluations was not achieved, an oral and maxillofacial surgeon with a 20-year experience was consulted to confirm the final results.

The variables

The predictable variables were the grades (I, II, III), and the positional classes (I, II, III, and IV). The outcome variable was the IAN injury (numbness, reduced sensation or pain in the region innervated by the IAN).

Other variables included were the angulation (vertically, mesially, horizontally, invertedly, buccally or lingually impacted [10]) and impaction depth of the lower wisdom teeth (position A, B, C [10]).

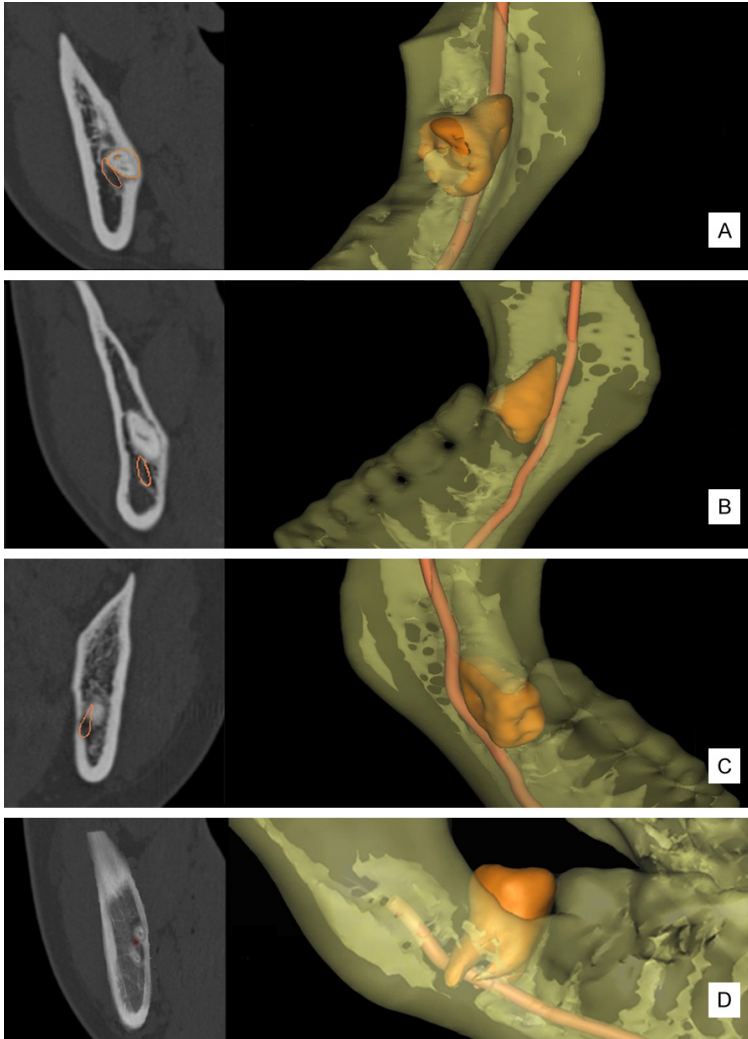


Figure 2. Classification of mandibular third molars based on the positional relation to IAC. A. Class I: on the lingual side; B. Class II: above the IAC; C. Class III: on the buccal side; D. Class IV: roots surrounding the IAC.

Table 1. Summary of impacted teeth in different grades and classes

Grades: proximity to IAC	Classes: positional relation to IAC			
	I	II	III	IV
I	17	15	1	1
II	8	20	3	0
III	4	16	7	0

Statistics

Data were analyzed using the SAS 8.2 statistical package (SAS institute Inc, USA), χ^2 test and Fisher test was used to analyze the data and a P value of <0.05 was considered statistically significant.

Results

92 complicated impacted mandibular third molars in 84 consecutive cases were included in the study. Of these, 40 were female (43 teeth), and 44 were male (49 teeth). Their ages ranged from 13 to 78 years (average, 31 years).

The OPG and CBCT revealed different grading in 8 teeth; where they were wrongly assumed to be in grade III on OPG, while, CBCT showed them in grade I (n=3) and II (n=5) (Figure 2D). Table 1 summarizes the number of teeth found in different grades and classes based on CBCT findings.

IAN injury was found in 7 out of 92 extractions (7.61%). Of these, three were in grade III and class III, two were in degree III and class II, and another two were in degree II and class II (Table 2). The subjects with higher grades appeared to have a greater risk of IAN injury. Furthermore, the incidence of injury was highest in class III teeth (P<0.05) (Table 3).

Discussion

Extracting the complicated mandibular third molars is of a great challenge and having higher risks to cause severe complications. The procedure requires an experienced surgeon and good equipments with a higher accuracy and safety like the piezosurgery [11]. Meanwhile, it is necessary to evaluate the risk of complications from an objective point of view. In our clinical practice, we found that 79.31% of the complicated impacted teeth were in a close proximity to the IAC in OPG, suggesting the importance of the risk evaluation especially in the complicated teeth.

The proximity and positional relation between the tooth root and the IAC are the most important risk factors reflecting the risk degree and helping the surgical plan [10, 11]. However, to

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Table 2. Summary of cases with inferior alveolar nerve injury

No.	Age	Gender	Pell&Gregory Classification (depth of impaction)	Winter's Classification (angulation)	Grades (proximity to IAC)	Classes (positional relation to IAC)	Duration
1	50	male	Position C	inverted	II	II	6 Mo
2	37	female	Position C	inverted	III	II	3 Wk
3	20	female	Position B	horizontal	III	III	2 Wk
4	57	female	Position B	vertical	III	II	1 d
5	26	male	Position B	horizontal	II	II	1 d
6	20	female	Position B	horizontal	III	III	1 d
7	38	male	Position C	horizontal	III	III	1 d

Table 3. Correlation of inferior alveolar nerve injury, grade and class (case)

Grades/Classes	Injury	No injury	Total	P
Grade: proximity to IAC				
I	0	34	34	0.0168*
II	2	29	31	
III	5	22	27	
Class: positional relation to IAC				
I	0	29	29	0.0387*
II	4	47	51	
III	3	8	11	
IV	0	1	1	

*Differences between groups were compared using χ^2 test. P values of <0.05 were considered statistically significant.

our knowledge, no study combined the two factors for evaluation of the risk till now.

The proximity of the tooth root to the IAC, evaluated by the OPG or coronal reconstruction of CBCT, is one of the important risk factors of the IAN injury. Several studies focused on the discussion of this factor. Rood et al. [12] suggested seven radiographic indicators describing the proximity of the tooth root to the IAC, of which, four were about the root (darkening, deflection, narrowing of the root, and a bifid root apex), and the other three were about the IAC (diversion, narrowing, and interruption of the white line of the IAC). The classification was complex, with a little clinical evidence. Juodzbalys et al. [13] presented a risk degree classification based on the proximity of the impacted tooth root to the IAC as follows: 0= more than 3 mm from the IAC, 1= contacting or penetrating the IAC with its wall identified, 2= contacting or penetrating the IAC with its wall unidentified, 3= the root surrounding the IAC. However, there

are some drawbacks in this degree classification namely: the choice of “3 mm” and its measuring method was confusing, teeth with a distance less than 3 mm to the IAC were not included, and there was no clinical evidence supporting the study. However, in the current study, the evaluation of the proximity could be applied in all teeth in close proximity to the IAC. Furthermore, we found the risk degree is correlated with the incidences of the IAN injury, which confirmed the clinical relevance. Park et al. [14] reported that the incidence of IAN injury was higher with absence of cortication around the mandibular canal. Similarly, we found the incidence of the IAN injury after extractions of teeth in grades I, II and III were 0%, 6.45% and 18.52% respectively (P<0.05).

Both OPG and CBCT are of a great value in evaluating the proximity of the tooth root to the IAC. However, OPG has the shortcoming of the overlapping of the images [15]. On the other hand, by providing multi-dimensional images, CBCT can reveal a more precise relation between the different anatomical structures [16-18]. In our study, teeth contacting or compressing the IAC on the lingual or buccal sides could be misdiagnosed to be in grade III in OPG (**Figure 1D, 1E**). Thus, using CBCT as a complementary imaging tool is suggested in teeth closely related to the IAC, especially in those penetrating the IAC.

Positional relation between the impacted tooth and the IAC is another important risk factor which is best evaluated by the coronal reconstruction of CBCT. We previously reported that teeth on the buccal side of the IAC had the highest risk of IAN injury [8], which goes in concor-

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dance with the results of the current study. This finding could be related to the direction of the extraction force which is usually downward and lingually (more cancellous bone), and in addition to the fact that the percentage of teeth compressing or penetrating the IAC on its buccal side is higher than those above the IAC (**Table 1**). The extraction vector of teeth with roots surrounding the IAC (class IV) will be at least in two directions, and therefore having a higher risk of IAN injury. Unfortunately, only one case in class IV was included in this study, accordingly, no conclusion can be drawn out due to the insufficient data.

IAN injury with temporary numbness in the ipsilateral half of the lower lip was found in 7 mandibular third molar teeth (**Table 2**). They were deeply impacted (position B or C); mostly horizontally or inversely impacted; compressing or penetrating the IACs; above or on the buccal side of the IACs. Therefore, they were difficult to extract, owing to the large adjacent teeth and/or bone resistance, which should be released either by complete bone removal and/or tooth sectioning. The risk of IAN can be minimized by avoiding forces directed to the IAC during extraction.

Conclusion

The presented new classification system, based on the proximity and positional relation between the tooth root and the IAC is proved to be valuable in detecting wisdom teeth with higher risk of IAN injury during extraction, and hence provide a good guidance for the appropriate surgical design, and extraction vector selection.

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Disclosure of conflict of interest

None.

Address correspondence to: Dr. Chi Yang, Department of Oral and Maxillofacial Surgery, Shanghai Ninth People's Hospital, School of Medicine, Shanghai Jiao Tong University, and Shanghai Key Laboratory of Stomatology, 639 Zhi-Zao-Ju Rd, Shanghai 200011, China. Tel: +86-13818712506;

Fax: +86-2123271047; E-mail: yangchi63@hotmail.com

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