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CONGRESS PROCEEDING

High-Risk Factors Associated With Inferior Alveolar Nerve Injury Following Removal Of The Third Molars: A Preliminary Study

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Abstract

Purpose: This study aims to determine the incidence of inferior alveolar nerve (IAN) injury following the extraction of the lower third molars (LTMs) and to identify the demographic, radiographic, and intra-operative risk factors associated with this complication.
Materials and Methods: : Fifty LTMs from 47 patients were included in this prospective clinical study. Demographic data and intra-operative parameters including operation time, bone removal and duration, excessive bleeding and IAN exposure were recorded. Bone retention, anatomical position of LTMs (Pell&Gregory and Winter classification) and 5 radiographic criteria proposed by Rood and Shehab were evaluated on panoramic images, whereas the distance between roots and the inferior alveolar canal (IAC), the cortication status of IAC, and the buccolingual position of IAC were examined on CBCT images. Chi-square test was used to compare the presence of IAN injury with variables. A p-value < 0.05 was considered as statistically significant.
Results: The incidence of temporary IAN injury was 6% among study population. No permanent IAN injury was observed. Excessive bleeding (p=0.007), IAN exposure (p=0.007), the lingual position of IAC (p=0.035) and dumbbell-shaped IAC (p=0.002) were found to be associated with increased risk of temporary IAN injury.
Conclusions: Identification of high-risk factors is essential for predicting the risk of IAN injury, and determining the most convenient treatment plan for each case. Further studies with larger study samples are needed both to confirm the risk factors that are proposed in the present study and to identify the other potential ones.

Key words: third molars; inferior alveolar nerve injury; paresthesia

Introduction

Extraction of lower third molars (LTMs) is one of the most frequently performed procedures in oral surgery.1The temporary/permanent neurosensorial impairment is a significant complication associated with extraction. The symptoms caused by inferior alveolar nerve (IAN) injury include burning, numbness, involuntarily lip/tongue biting, difficulty during speaking, and an electric shock-type feeling on the affected side. Cases that do not show any sign of recovery within 6-12 months are considered permanent. The reported incidence of temporary IAN injury varies between 0.35% and 19.8% [1–3], while the incidence of permanent IAN injury ranges from 0.28% and 6.5% [2–4].Although many patients experience temporary IAN injury symptoms, the negative impact on the individual's quality of life can be massive. [1]

Efforts have been made to identify the risk factors contributing neurosensorial complications after the extraction of LTMs. [1–4]Patient's age and gender, impaction type and position of LTMs, the anatomical relationship of LTM and IAC have been reported to be associated with a higher risk for IAN injury. [1–4]However, it is essential to take consideration into all aspects including patients' demographics and medical history, preoperative radiographic assessment and adjacent anatomical structures to establish an accurate treatment plan. [4]

In this study, we investigated the incidence of IAN injury fol-

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lowing the extraction of LTMs and determined the demographic, radiographic, and intra-operative risk factors associated with this debilitating complication.

Methods

The study protocol was approved by the Ethics Committee of Ege University (Approval no: 19-10.1T/65, 16/10/2019) and planned in accordance with Helsinki declaration.

Patients who applied to outpatient clinic of Faculty of Dentistry, Ege University between December 2019 and April 2021 were included in this prospective clinical study. Inclusion criteria were, patients older than 18 years of age, clinical and radiographical diagnosis for surgical removal of LTM, presence of both panoramic radiography (PR) and cone-beam computed tomography (CBCT) images with acceptable image quality for the diagnostic information, and consent to participate. Prior to surgery, each patient was informed of the risk of possible complications and was asked to sign a consent form. Patients with intraosseous pathologies such as cysts and tumors, periapical pathologies and/or previous endodontic treatment and any sensory impairment history associated with IAN or due to a systemic neurological disease were excluded from study. The study variables were subclassified as demographic, radiologic and intra-operative. Demographics including age, gender, body mass index, presence of systemic disease and medication, and smoking habits were recorded. Preoperative panoramic imaging was performed with Kodak 8000 Digital Panoramic System (Kodak Carestream Health, Trophy, France) (70 kV, 16 mA, 17,6 s). CBCT images were obtained with Kodak 9000 3D DVT (Kodak Carestream Health, Trophy, France) (70 kV, 10 mA, 10.8s) (voxel size: 76 $*\mu$m) (field of view: 50 x 37 mm). Bone retention, angulation and position of the tooth and 5 radiographic criteria proposed by Rood and Shehab [5] including the darkening of the roots, narrowing of the roots, interruption of cortical margin of the IAC, diversion and narrowing of the IAC were evaluated on PR images. On coronal CBCT images the distance between the root apex and IAC, the cortication status and buccolingual position of IAC and IAC morphology were examined. Both PR and CBCT images were assessed by 2 independent observers (B.K. senior and N.E.O. junior oral radiologists with 20 and 2 years of experience respectively).

A standard surgical approach was applied by the same surgeon (M.O.Y. senior oral surgeon with 14 years of experience). Bone removal and tooth sectioning were carried out when necessary. Intraoperative data including total operation time, bone removal and duration, presence of excessive bleeding and IAN exposure were noted. Patients were prescribed antibiotics (875 mg amoxicilin /125 mg clavulanic acid), analgesics (500 mg paracetamol) and antimicrobial mouthwash (2%, clorhexidin gluconate) after surgery. The neurosensory status of the IAN was evaluated both pre-operatively and at post-operative 1 week. The light touch and two-points discrimination tests were performed on operation area and contralateral side. If neurosensory abnormalities were identified, subjects were monitored until remission of all symptoms.

Statistical analyses were performed using SPSS 25.0 (Chicago, IL). Chi-square test was used to analyze the correlation between the presence of IAN injury and demographic, intra-operative and radiological parameters ($p< 0.05$).

Results

Fifty LTMs from 47 patients were enrolled in the study. The incidence of temporary IAN injury was 6% among study population (n=3). No permanent IAN injury was observed.

The study group included 26 (55.3%) females and 21 (44.7%) males. The age of the patients ranged from 21 to 56 years (mean age: 28.2). The majority (78%) of the study population had no medical disorders, while only 14% were on medication due to a systemic disease. Most of the patients were identified as having a 'healthy' body mass index (BMI) (18.5-24.9) (24%) and 28% were overweight (25-29.9). Smoking habit was noted only for 38% of the population. No statistically significant influence of demographic features were observed on the risk of IAN injury ($p>0.05$) (Table 1).

Bone retention was present on PR images in 66% of the patients. The most common angulation types were vertical (38%) and mesioangular (38%). The majority of the LTMs were in Class II (78%) ramus relationship, and Class B (50%) was the most common impaction type. Darkening of the roots and interruption on cortical margin of the IAC were common, whereas diversion of the IAC (6%), narrowing of the IAC (6%), and narrowing of the roots (4%) were less common. All patients that experienced temporary IAN injury had bone retention ($p=0.313$) and darkening of the roots ($p=0.550$) on PR images. However, radiological features as evaluated on PR images had no significant impact on temporary IAN injury ($p>0.05$) (Table 2).

The distance between the root apex and IAC was found to be less than 1 mm (< 1mm) in 44 (88%) cases. The cortication of the IAC was preserved in 42%, whereas interruption of the cortical margin was observed in 58%. The most common position for IAC was noted as inferior (40%) followed by buccal (26%). The morphology of IAC was round/oval in the majority of the study group (76%). The lingual position of IAC ($p=0.035$) and dumbbell-shaped IAC ($p=0.002$) were associated with increased risk of temporary IAN injury. Although not statistically significant, temporary IAN injury tended to occur in cases with interruption of the cortical margin and a root apex and IAC distance less than 1 mm (Table 2).

The surgery was completed in 16-30 min (44%) for most of the cases. Bone removal was performed in 74% of the patients among whom 3 of them had temporary neurosensorial impairment. However, bone removal was not associated with increased risk of IAN injury ($p=0.290$). The duration of the bone removal was equally distributed among the study group (Table 1). Excessive bleeding and IAN exposure during the operation were observed in 6% of the patients and were found to be high-risk parameters for temporary IAN injury ($p=0.007$) (Table 3).

Discussion

Neurological complications following extraction of LTMs remain a significant clinical and medicolegal concern for the clinicians. [2] Therefore, it is of great importance to evaluate the risk factors contributing to IAN injury to adequately inform patients regarding the potential risks of the operation, and to secure a proper treatment planning. [4]

The relationship between IAN injury with age and gender has been investigated very often, yet the results of the studies are controversial. [2] In addition, other demographic features such as BMI, systemic disease and medication, and smoking habits have been rarely studied. The present study did not reveal any statistically significant correlations between demographic features and IAN injury. The small sample size and unequal distribution of demographic features within the study group may lead to this finding.

The radiographic features that are associated with IAN injury are darkening of the roots, interruption of cortical margin of the IAC, diversion and/or narrowing of the IAC. [2] All the cases with temporary IAN injury had bone retention and darkening of the roots on PR images in the present study, and were identified as Class II regarding the relationship with ramus. However, none of these parameters were found to be significant risk factors when predicting IAN injury and PR images alone did not provide accurate information for predicting the risk. The distance and relationship between the root apex and IAC can be misinterpreted on PR images due to the inclination of X-ray beam and the distortions of the size and shape of the object. [6] Therefore, when a close anatomic

Table 1. Demographic data of the study sample and p-values of the parameters. (*Statistical significance)

Demographic Parameters		Number (n, %)	IAN Injury (n)	p-value (<0,05*)
Age	18-25y	25 (%50)	1	.180
	26-30y	13 (%26)	0	
	>30 y	12 (%24)	2	
Gender	Female	29 (%58)	2	.754
	Male	21 (%42)	1	
Body Mass Index (BMI)	<18,5	9 (%18)	0	.729
	18,5- 24,9	12 (%24)	2	
	25- 29,9	14 (%28)	1	
	30- 40	5 (%10)	0	
	>40	0 (%0)	0	
Systemic Diseases	Healthy	39 (%78)	2	.691
	Cardiovascular Diseases	4 (%8)	1	
	Endocrine Disorders	1 (%2)	0	
	Respiratory System Diseases	1 (%2)	0	
	Autoimmune Disorders	0 (%0)	0	
	Psychological Disorders	0 (%0)	0	
	Others	4 (%8)	0	
	Multiple System Diseases	1 (%2)	0	
Medication Use	Yes	7 (%14)	1	.370
	No	43 (%86)	2	
Smoking Habits	Not smoker	31 (%62)	1	.570
	<20 cigs per day	10 (%20)	1	
	>20 cigs per day	9 (%18)	1	

*Chi-square test was applied as statistical method.

Table 2. Radiological data of the study sample and p-values of the parameters. (*Statistical significance)

Radiological parameters (PR)		Number (n, %)	IAN Injury (n)	p-value (<0,05*)
Bone retention	Yes	33 (%66)	3	.313
	No	17 (%34)	0	
Winter Classification (Angulation)	Horizontal	9 (%18)	0	.834
	Vertical	19 (%38)	2	
	Mesioangular	19 (%38)	1	
	Distoangular	3 (%6)	0	
Pell & Gregory (Ramus relationship)	Class I	1 (%2)	0	.622
	Class II	39 (%78)	3	
	Class III	10 (%20)	0	
Pell & Gregory (Impaction depth)	Class A	20 (%40)	0	.324
	Class B	25 (%50)	2	
	Class C	5 (%10)	1	
Darkening of the roots	Yes	36 (%72)	3	.550
	No	14 (%28)	0	
Narrowing of the roots	Yes	3 (%6)	1	.173
	No	47(%94)	2	
Interruption of cortical margin of the IAC	Yes	36 (%72)	2	1
	No	14 (%28)	1	
Diversion of the IAC	Yes	2 (%4)	1	.118
	No	48 (%96)	2	
Narrowing of the IAC	Yes	3 (%6)	0	1
	No	47 (%94)	3	
Radiological parameters (CBCT)				
The distance between the roots and IAC	<1 mm	44 (%88)	3	1
	2 mm	5 (%10)	0	
	>2 mm	1 (%2)	0	
The cortication of IAC	Present	21 (%42)	0	.254
	Absent	29 (%58)	3	
The buccolingual position of IAC	Buccal	13 (%26)	0	.035*
	Lingual	12 (%24)	3	
	Inferior	20 (%40)	0	
	Interradicular	5 (%10)	0	
The morphology of IAC	Round/oval	38 (%76)	0	.002*
	Teardrop	5 (%10)	0	
	Dumbbell	7 (%14)	3	

*Chi-square test was applied as statistical method.

Table 3. Intra-operative data of the study sample and p-values of the parameters. (*Statistical significance)

Intra-operative Parameters		Number (n, %)	IAN Injury (n)	p-value (<0,05*)
Total operation time	0-15 min	17 (%34)	1	.117
	16-30 min	22 (%44)	0	
	31-45 min	11 (%22)	2	
Bone removal	Yes	37 (%74)	3	.290
	No	13 (%26)	0	
Duration	None	13 (%26)	0	.751
	0-3 min	13 (%26)	1	
	4-6 min	5 (%10)	0	
	7-9 min	10 (%20)	1	
	>9 min	9 (%18)	1	
Excessive bleeding	Yes	3 (%6)	2	.007*
	No	47 (%94)	1	
IAN exposure	Yes	3 (%6)	2	.007*
	No	47 (%94)	1	

*Chi-square test was applied as statistical method.

relationship is suspected on PR images, CBCT imaging should be performed to precisely define the relationship of the LTMs to vital structures.[7] The position and morphology of IAC, the cortication status of IAC that have been previously reported to be associated with IAN injury.[4,7]Ueda et al.[8] suggested that dumbbell-shaped IAC morphology is a significant feature when predicting IAN damage, since it reflects the close anatomical relationship of IAC and the roots of LTMs. Similarly, dumbbell-shaped canal morphology was associated with increased risk of temporary IAN injury in the present study. The lingual position of IAC has also been reported as a high-risk parameter for temporary IAN injury which may result due to the compression of IAN that is located between the lingual cortical bone and tooth roots with the force applied during extraction.[4] In accordance with the previous reports the exposure of IAN and excessive bleeding during operation were associated with increased risk of IAN injury in the present study.[2,7]Direct mechanical trauma from surgical drills and elevators to the exposed IAN or indirect trauma from post-operative edema or hematoma may account for this finding. It is essential to clarify if excessive bleeding is a consequence of damage to the inferior alveolar neurovascular bundle or a result of bone removal and tooth sectioning to predict the severity of the complication.

Our results indicated that the risk of IAN injury has a stronger relationship with intra-operative parameters and radiological features on CBCT images rather than demographic characteristics and PR features. Nonetheless, our results should be evaluated carefully due to the limited number of patients and it is recommended that further studies with larger study samples are needed to confirm our findings and to identify potential risk factors.

Conclusion

Identification of high-risk factors is essential for predicting the risk of IAN injury and determining the most convenient treatment plan for each patient. IAN injury was significantly associated with excessive bleeding and IAN exposure during the operation in the present study. Additionally, the lingual position of IAC and dumbbell-shaped IAC morphology were found to be high-risk factors.

Author Contributions

All authors made substantial contributions to the present study. NEO, BK and PG designed the study, NEO and MOY contributed to data collection, HB analyzed to data, PG, BI, and NEO contributed to interpretation of data and editing of the manuscript. PG, BI and NEO wrote the manuscript. All authors read and approved the final manuscript.

Conflict of Interest

All the authors declare they have no financial interests.

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