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ORIGINAL RESEARCH

Inferior alveolar nerve injury in impacted mandibular third molar: Prevalence and associations

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Abstract

Background: Injury to the inferior alveolar nerve can occur as a result of proximity of the root of the impacted mandibular third molar to the canal.

Objectives: This study aims to prospectively assess injury to the inferior alveolar nerve due to its proximity to the root of the impacted mandibular third molar as well as associated risk factors.

Methods: This was a double-blind observational study to assess injury to the inferior alveolar nerve after the surgical removal of the impacted mandibular third molar. Subjects who met the inclusion criteria were evaluated for lower lip numbness before and after the surgery. Data were analysed using IBM SPSS Statistics for Windows, Version 25.0. The level of significance was set at $p<0.05$.

Results: 123 impacted mandibular third molars were extracted. There were 39 (31.7%) males and 84 (68.3%) females, with ages ranging from 18 to 66 years and a mean (±SD) age of 24.82 (±9.18). The most common radiographic prediction sign was darkening of the root apex, observed in 72 (58.5%) cases. The 2 (1.6%) subjects who experienced inferior alveolar nerve injury, had diversion of the inferior alveolar canal as their radiographic prediction sign, and this was statistical significance ($p=0.001$).

Conclusion: Injury to the inferior alveolar nerve is a nuisance to both the surgeon and patient. It is important for the surgeon to be familiar with the risk factors associated with developing injury and inform patient accordingly.

Keywords: Impacted mandibular third molar, Inferior alveolar canal, Inferior alveolar nerve injury, Radiographic prediction sign, Risk factor

Introduction

Surgical removal of the impacted mandibular third molar is one of the most common procedures performed in oral surgery. [1] This makes it a relatively frequent procedure overall in dentistry. Complications can arise from extracting the impacted mandibular third molar, and one such complication is nerve injury. Inferior alveolar nerve injury is defined as any sensory impairment experienced after the removal of the impacted mandibular third molar.[1] Injury to the inferior alveolar nerve is a serious complication following the extraction of the impacted mandibular third molar.[2,3] This injury is a significant issue because it can affect the patient's quality of life, causing numbness or pain in the skin around the chin, lower lip, and lower corner of the mouth, as these areas are innervated by the inferior alveolar nerve.[2,4]

Injury to the inferior alveolar nerve can be temporary or permanent. Usually, if the injury to the nerve does not spontaneously heal within 6 months, it is assumed to be likely a permanent damage.[5] The incidence and prevalence of nerve injury after the surgical removal of the impacted mandibular third molar vary among studies. Incidence ranging from 0.26% to 20% has been reported.[2,3] Incidence of permanent damage has been reported to range between 0-2%, while temporary damage that ranges from 0.4 to 20% has been reported; however, this could go as high as 30% if the root of the impacted mandibular third molar is proximally close to the inferior alveolar nerve.[1,5, 6]

Several risk factors are associated with nerve injury, and they include patient age, gender, relationship of the root and the mandibular canal, surgeon's experience, local blood supply, and the type and extent of impaction.[1,2,3] Some injuries to the inferior alveolar nerve are avoidable only if the surgeon can pay attention to some of these factors and prepare adequately to avoid them. For example, the inferior alveolar nerve, which runs within the mandibular canal, is supported by the alveolus and the neurovascular bundle, with the inferior alveolar vein being the most superior in the canal, and this serves as a significant clinical correlation in alerting the surgeon when bleeding is experienced during the surgical extraction of the impacted mandibular third molar.[1] With consideration to the type and extent of impaction, it can be classified as mesioangular, horizontal, vertical and distoangular and according to depth as position A, B and C, and Class I, II and III, and this has been shown to play a role in developing injury to the inferior alveolar nerve.[1,4] For instance, horizontal impaction has been reported as the most implicated with nerve injury, with vertical being the least implicated.[1] Of all the various risk factors implicated in inferior alveolar nerve injury following the surgical removal of the impacted mandibular third molar, the most significant risk factor is the relationship between the impacted third molar's position and its proximity to the inferior alveolar nerve.[2, 4]

Injury to the inferior alveolar nerve can occur during the surgical removal of the impacted mandibular third molar due to the proximity of the root.[5,7] To identify this proximity of the impacted mandibular third molar and inferior alveolar nerve, radiographic assessment is usually done, and seven radiographic signs have been suggested.[7] Of these seven radiographic

signs, four are related to the root of the impacted mandibular third molar, and the other three are related to the inferior alveolar canal.[4] These radiographic signs in relation to the root are: darkening of the root, deflected roots, narrowing of the root, dark and bifid root and in relation to the inferior alveolar canal; interruption of white line(s), diversion of the inferior alveolar canal, and narrowing of the inferior alveolar canal.[4, 7] These radiographic signs have been implicated in nerve damage. It was reported in a retrospective study that all signs were related to nerve damage, except for the bifid root apex and darkening of the canal.[7] On the other hand, a prospective study reported nerve damage to be related to the diversion of the canal, followed by darkening of the root and interruption of the canal.[7] Signs, such as narrowing of the root, dark and bifid root, narrowing of the inferior alveolar canal and deflected root, were found to be statistically unrelated in a prospective study.[7]

Injury to the inferior alveolar nerve is a nuisance to both the surgeon and the patient. Patients often complain of a strange feeling of discomfort. This can lead to litigation, especially if the patient is not adequately informed before the procedure. It is of utmost importance to know the prevalence of this injury to aid communication with patient as well as the most implicated radiographic prediction signs and risk factors associated with this injury. The literature contains several studies on the impacted mandibular third molar; however, there are few studies on the inferior alveolar nerve injury due to the root proximity of the impacted mandibular third molar to the inferior alveolar nerve, as well as risk factors associated with it. Thus this study seeks to prospectively assess injury to the inferior alveolar nerve due to its proximity to the root of the impacted mandibular third molar as well as associated risk factors.

Methods

This study was conducted at the Dental Department, Babcock University Teaching Hospital, Ogun State, from April 2024 to November 2025. This study was a double blind observational study to assess injury to the inferior alveolar nerve in impacted mandibular third molars as well as associated risk factors. All consenting subjects who presented to the dental clinic for the extraction of their impacted mandibular third molar and met the inclusion criteria were evaluated.

The inclusion criteria were;

i. Subjects who gave their consent and were 18 years and above
ii. Subjects with impacted mandibular third molars.
iii. Subjects that were free of clinical evidence of local infection and were willing to return for follow-up visits.

The exclusion criteria were subjects who did not give informed consent, and subjects with systemic diseases that can complicate treatment

All subjects who presented to the dental clinic with complaints related to their impacted mandibular third molars and who met the inclusion criteria were recruited into the study.

Ethical approval was obtained from the Health Research Ethics Committee, Babcock University, with assigned number BUHREC 316/25.

The sample size for this study was calculated using the formula for estimating a single proportion:

$n = Z^2 . p . (1-p)/d^2$

Where:

n = required sample size

Z = 1.96 at 95% confidence interval

p = expected prevalence of inferior alveolar nerve injury (0.84% from previous studies).[1]

d = precision (margin of error) of 5% = 0.05

$n = 1.96^2 \times 0.084 (1-0.084)/0.05^2$

n = 118

However, 130 subjects were enrolled on this study, and 123 completed it.

Study protocol

Preoperative assessment: The study was explained in detail to each eligible subject, after which informed consents were taken from subjects who were willing to participate. Preoperative data such as age, gender, type of impaction, difficulty index (Pederson index), and proximity of the impacted mandibular third molar root to the inferior alveolar nerve (prediction sign) were recorded in the proforma. A digital panoramic radiograph was taken and used for the preoperative assessment of each of the eligible subjects. The radiographic signs, type and level of impaction were obtained from the digital panoramic radiograph and recorded in the proforma after screening by two Oral and Maxillofacial Surgeons who are skilled in the interpretation of the panoramic radiograph, and where doubt exists, a third Oral and Maxillofacial Surgeon comes in. Neurosensory deficit was assessed before the procedure. The preoperative and postoperative assessments were carried out by a research assistant who was at the level of a dental officer and had been calibrated. These assessments included the pin-prick, two-point discrimination and brush directional stroke test and these were used to measure neurosensory deficit caused by injury to the inferior alveolar nerve on the lower lip. These tests were demonstrated on the subject by a Consultant before the commencement of the research, and the Dental officer was asked to repeatedly demonstrate it before the commencement of the research.

Intervention: The conventional rotary handpiece was used in the surgical extraction of all impacted mandibular third molars. The surgical procedure was performed by a single Oral and Maxillofacial Surgeon.

Postoperative assessment: The subjects were assessed for neurosensory deficit on the day of the procedure before the surgical extraction and on postoperative day 7. Neurosensory deficit of the inferior alveolar nerve was assessed on postoperative day 7 around the chin on both sides. This assessment was measured using pin-prick, two-point discrimination and brush directional stroke test.[6] Subjects were asked to close their eyes before the assessment.

In the pin-prick test, the subjects were repeatedly touched with an explorer tip around the skin on the chin. This was done ten times (to allow room for elimination of subjectivity), and the number of times the subject accused the contact was recorded. In the two-point discrimination test, the compass ends were applied ten times in a disordered, separated manner, and subjects were asked to distinguish the sensitivity of one or two points. In the brush directional stroke test, the brush was applied

following a pattern, and the subjects were asked to indicate the direction.

Blinding

The subjects had their eyes closed and were oblivious of when the contacts and assessments were being introduced during the measurement. The research assistant who performed the assessments was not aware of the side from which the extraction was performed.

Data Analysis

Data was analysed using the statistical package for social sciences (SPSS) for Windows (IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp.). Descriptive statistics (mean, median, and standard deviation) were performed on continuous variables, while frequency was performed on categorical variables. Association between categorical variables were tested using Chi-square or Fischer's exact where appropriate. The critical level of significance was set at $p<0.05$.

Results

One hundred and twenty three (123) subjects were recruited into this study. There were 39 (31.7%) males and 84 (68.3%) females in this study. The age ranges from 18 years to 66 years with a mean (±SD) of 24.82 (± 9.18) years, Figure 1.

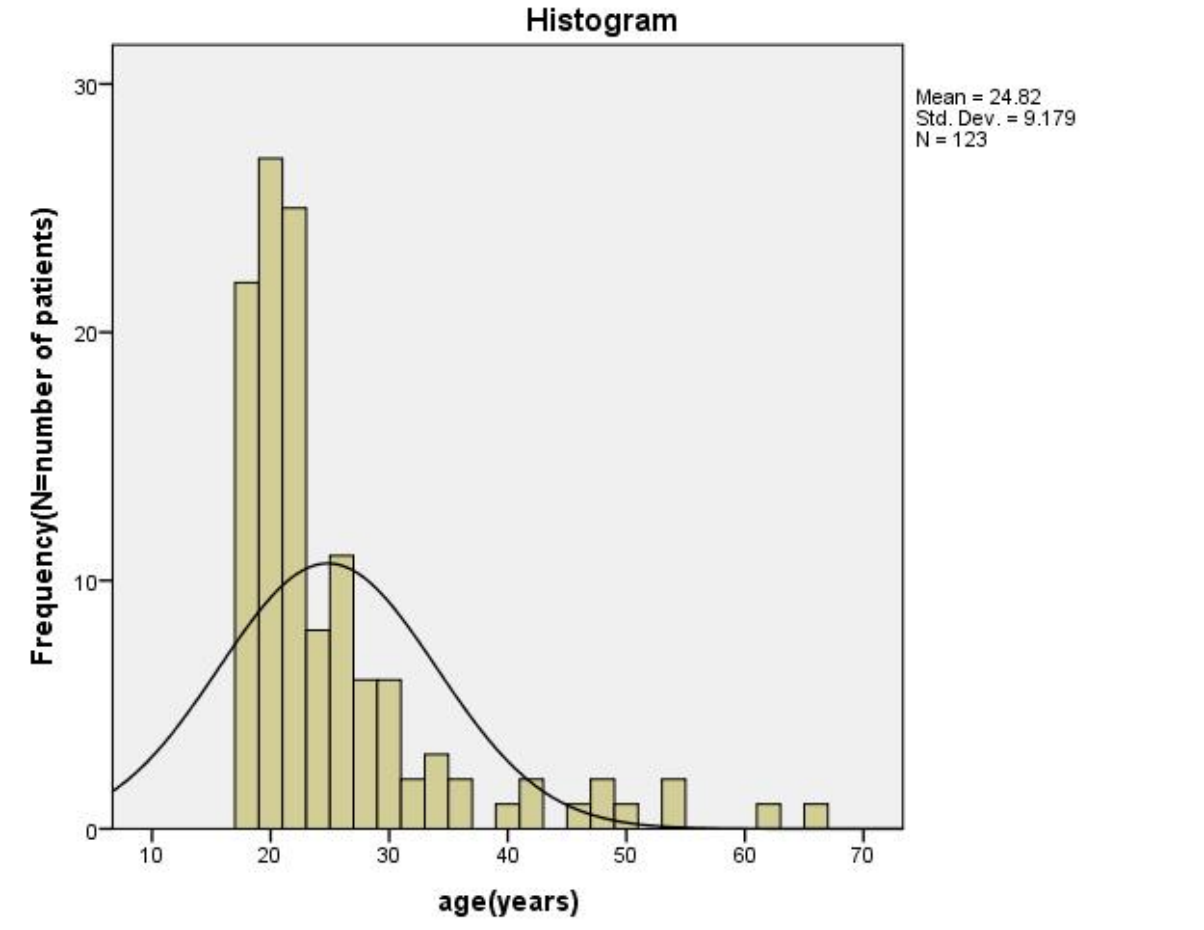


Figure 1: Age distribution of the Patients

Only 2 (1.6%) subjects had inferior alveolar nerve injury. Mesioangular and class I impaction account for more than half of the overall impaction (58.5% and 61.8%), respectively. Position B impaction was the commonest. The most common radiographic prediction sign was the darkening of the root apex, accounting for 72 (58.5%), Table I.

Table I: Distribution of Impaction and Prediction signs

Variables	Frequency n=123	Percentage
Injury		
Yes	2	1.6
No	121	98.4
Type of Impaction		
Mesioangular	72	58.5
Horizontal	14	11.2
Vertical	17	13.8
Distoangular	20	16.3
Position of Impaction		
Position A	46	37.4
Position B	49	39.8
Position C	28	22.8
Class of Impaction		
Class I	76	61.8
Class II	42	34.1
Class III	5	4.1
Prediction Signs		
Darkening of root apex	72	58.5
Dark and bifid root apex	23	18.7
Deflection of the root	15	12.2
Narrowing of the root	1	0.8
Interruption of white line	6	4.9
Diversion of the canal	6	4.9
Narrowing of the canal	0	0

Six (6) subjects had diversion of the inferior alveolar canal as their radiographic prediction sign, and out of this, 2 developed injury to the inferior alveolar nerve and this was statistically significant (p-value = 0.001). Distoangular impactions also significantly affect injury to the inferior alveolar nerve, Table II.

The majority of the mesioangularly impacted teeth have a prediction sign of darkening of the root apex, and interruption of the white line was almost exclusively related to horizontal impaction. There was a significant statistical difference when these associations were tested (Table III).

Discussion

Symptoms resulting from injury to the inferior alveolar nerve during the surgical extraction of the impacted mandibular third molar can be very frustrating for both the patient and the surgeon. However, this injury can be carefully avoided through proper preoperative and intraoperative planning. When there is doubt that injury may still occur, the patient should be informed beforehand. The mean age in this study was 24.82 years, with more females than males. A similar study reported a mean age of 26.3 years, with more male subjects.[4] Kim *et al*.[3] reported an average age of 33.5 years, with more female subjects. The slight variation may be due to different geographic locations.

The incidence of injury to the inferior alveolar nerve in this study was 1.6%. Subjects with this injury did not recover from the lower lip paraesthesia even after over six months of follow up.

Table II: Factors associated with inferior nerve injury

Variables	Frequency n=123		X^2	P-Value
Association of Radiographic Prediction Signs with Nerve Injury				
Nerve Injury	No	Yes		
Darkening of root apex	72			
Dark and bifid root apex	23			
Deflection of the root	15			
Narrowing of the root	1	0		
Interruption of white line	6	0		
Diversion of the canal	4	2	*15.026	0.001
Narrowing of the canal	0	0		
Association of Injury with Impaction				
Mesioangular	72	0		
Horizontal	14	0		
Vertical	17	0		
Distoangular	18	2	10.476	0.015

The reported prevalence of injury to the inferior alveolar nerve after surgical removal of the impacted mandibular third molar ranges between 0.2%-20%.[2,3,8,9] Incidence of temporary injury that ranges from 0.4%-20% have been reported with permanent injury of 0-2%.[1] Our study reported an incidence of permanent damage of the inferior alveolar nerve after surgical removal of the impacted mandibular third molar to be 1.6%. This incidence is within the 0-2% reported in previous study.[1]

The radiographic prediction signs are helpful in determining injury to the inferior alveolar nerve. Darkening of the root apex was the most common radiographic prediction sign in this study, followed by dark and bifid root apex. This aligns with Kim *et al*.[3], who also reported darkening of the root as the most common sign. Costa *et al*.[6] identified narrowing of the canal as the most frequent prediction sign, followed by darkening of the root apex. Even though diversion of the canal was not the most frequent radiographic prediction sign in this study, all the injuries reported were associated with it. Similar to our study, Leung and Cheung[10] reported the highest incidence of nerve injury among cases with canal diversion. Costal *et al*.[6] on the other hand, did not find an association between radiographic prediction signs and nerve injury. A retrospective and prospective study identified three significant radiographic predictive signs of nerve injury: darkening of the canal, diversion of the canal, and interruption of the white line.[7]

Table III: Radiographic Prediction Signs with the Levels of Impaction

Variables		Prediction signs						X^2	P-value
	Darkening of root apex	Dark and bifid root apex	Deflection of the root	Diversion of the canal	Interruption of white line	Narrowing of the root	Narrowing of the canal		
Type of Impaction									
Mesioagular	41	21	6	3	1	0	0		
Horizontal	7	1	1	0	5	0	0	58.28	0.001
Vertical	12	1	3	0	0	1	0		
Distoangular	12	0	5	3	0	0	0		
Position of impaction									
A	31	7	6	0	2	0	0		
B	31	8	4	3	2	1	0	12.87	0.231
C	10	8	5	3	2	0	0		
Levels of impaction									
I	49	14	7	2	3	1	0	10.9	0.366
II	22	8	6	3	3	0	0		
III	1	1	2	1	0	0	0		
Association of Nerve injury with Prediction signs									
No	72	23	15	4	6	1	0		
Yes	0	0	0	2	0	0	0	*15.026	0.001
Position of impaction									
No	A	B	C						
Yes	46	48	27						
	0	1	1					1.476	0.478
Class of impaction									
	I	II	III						
No	76	41	4						
Yes	0	1	1					11.96	0.003
Association of gender with injuries									
	Male	Female							
No	39	82							
Yes	0	2						0.944	0.331

*= Fischer's exact

The study further stated that canal diversion was the most significant radiological predictor, with one in three subjects showing this sign experiencing lip

numbness.[7] This finding is similar to our finding and the reason why diversion of the canal greatly influence injury to the inferior alveolar nerve may be due to the intimate relation of the root of the impacted mandibular third molar to the neurovascular bundle as it causes it to divert. Several risk factors have been shown to significantly predict injury to the inferior alveolar nerve during and after the surgical removal of impacted mandibular third molars. These include age, sex, impaction depth, surgeon's experience, surgical instrumentation, and postoperative oedema.[1, 11, 12]. It has been reported that age slightly influence the recovery of injury to the inferior alveolar nerve.[1] Our study reported a lower mean age and this might explain the lower injury reported. Gender did not significantly affect nerve injury, although all injuries reported in our study occurred in female subjects. Other studies have reported a higher prevalence of nerve injury among females.[3] Israr *et al*. [13] reported that age was not significantly linked to injuries, and although females had more injuries in their study, just like in our study, this was not statistically significant. The reason some studies suggest that female gender is a significant risk factor is due to the thinner cortical bone between the impacted molar's root and the inferior alveolar canal.[13 Distoangular impaction and class II and III were found to be a significant risk factor that influence nerve injury in our study. Other study has reported horizontal impaction and increased depth of impaction to be associated with neurosensory injury.[11] The surgeon's experience also significantly affects the risk of nerve injury, with less experienced surgeons tending to have higher incidences.[13] However, our study reported a low risk, because the procedures were performed by a single, highly experienced Oral and Maxillofacial Consultant specialized in third molar removal.

*Limitation*s: Some of the subjects were loss to follow up because they did not show up for follow-up assessment. This study is a single centre study and as such the results might not be generalizable to the entire population. A multi-centre study with a larger sample size is needed in order to generalize the results.

Conclusion

Injury to the inferior alveolar nerve following the surgical removal of the impacted mandibular third molar is a nuisance to both the patient and the surgeon. It is of paramount importance that the surgeon is familiar with the radiographic prediction signs and be equipped with the possible risk factors that can predispose a subject to inferior alveolar nerve injury. Where these risks are suspected, the patient should be adequately informed before the procedure, so as to avoid litigation.

Conflict of Interest: The authors declared no conflict of interest

Authors' Contributions: OE was involved in conception, acquisition and design, analysis and interpretation of data, drafting the article or revising it critically for important intellectual content and final approval of the version to be published, MASA was involved in analysis and interpretation of data, drafting the article or revising it critically for important intellectual content and final approval of the version to be published, TAO, OTO, HCA, and OCO were involved in analysis and interpretation of data, revising it critically for important intellectual content and final approval of the version to be published

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