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Radiographic findings associated with postsurgical nerve alteration in lower third molar surgery

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ABSTRACT

Objective: To identify the radiographic findings associated with postsurgical nerve alteration in lower third molar surgery in patients treated in the Faculty of Odontology operating room from 2015 to 2019. **Materials and methods:** This cross-sectional study included a population composed of medical records and panoramic radiographs of patients who underwent lower third molar extraction at the Faculty of Odontology, Universidad Central del Ecuador (FOUCE), from 2015 to 2019. The sample was selected based on inclusion and exclusion criteria. Radiographic predictor signs were observed, and the presence or absence of nerve alteration was assessed from the evolution notes. Data were recorded in an Excel file, and statistical analysis was conducted using SPSS version 25.0. Descriptive statistics for absolute and relative frequencies, as well as the relationship between variables, were analyzed using the Chi-square test with a confidence level of 95%. **Results:** The frequency of nerve alteration was 3.8% (n = 16); for patients older than 25 years, it was 9.7% (n = 7). For the Pell & Gregory classification, type C and class II had frequencies of 4.4% (n = 6) and 2.4% (n = 13), respectively. The dark and bifid root sign was found in 8.7% (n = 2) of the cases with nerve alteration. **Conclusions:** In third molar surgery, radiographic signs such as dark and bifid roots, loss of the white line, and canal deviation are associated with postsurgical nerve alteration.

Keywords: third molar; panoramic radiography; paresthesia.

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INTRODUCTION

The third molar is the most frequently impacted tooth, which is why it has become the most common surgery performed by dentists, oral and maxillofacial surgeons. Despite being a low complexity oral surgery, it is associated with multiple trans- and postoperative complications (1, 2). Among the complications related to the extraction of mandibular third molars, one of the most significant is injury to the inferior alveolar nerve. Clinically, this may present as hypoesthesia, hyperesthesia, anesthesia, or dysesthesia, and can be temporary or permanent if it persists for more than six months. According to several studies, its incidence ranges from 0.6% to 22% (3-5).

The inferior alveolar nerve, which runs through the mandible via the inferior dental canal, is generally located near the roots of the third molars, and has a greater relationship with these teeth when they are retained or impacted (6). Injury to the inferior dental nerve is usually one of the intraoperative complications that may occur during surgical procedures, such as the placement of dental implants or the extraction of impacted inferior third molars, so it is very important to know the anatomy and its trajectory (7).

Nerve injury has been defined as reversible or irreversible nerve damage caused by mechanical compression factors associated with normal or pathological anatomical structures, or by iatrogenic injuries during surgery (8). This results in altered sensory perception to mechanical stimuli and changes in sensitivity to touch and pressure, or even total loss of sensitivity in an anatomical area; however, other neurovegetative symptoms may also occur (9). Regarding the etiology of nerve injuries, it has mainly been described that they are of mechanical origin (due to compression, tears, sections, or avulsions), although there can also be a chemical cause due to the local anesthetic components, or due to improper thermal handling of surgical equipment, leading to bone overheating during the surgical procedure (6).

Conventional panoramic radiography is the most commonly used imaging test as a diagnostic tool in preoperative evaluation of mandibular third molars, mainly because of its cost and the fairly reliable information it provides to assess the proximity to the inferior alveolar canal (10). Although newer high-quality imaging options are available, these are not widely used due to poor accessibility and high costs, suggesting that these more advanced imaging techniques should be employed only when a significant proximity between both anatomical structures is observed (11-13).

In 1990, Rood & Shehab (14) described seven radiographic signs that could indicate a close relationship between inferior third molars and the inferior dental canal. Four of these signs are observed in the root of the third molar: root darkening, root deviation, root narrowing, and dark and bifid root. The remaining three radiographic signs are related to the inferior dental nerve canal, such as the interruption of the white line, deviation of the inferior alveolar canal, and narrowing of the dental canal.

In light of the above, the objective of this research is to identify the radiographic findings associated with postsurgical nerve alteration in inferior third molar surgery in patients treated in the operating room of the Faculty of Odontology of Universidad Central del Ecuador (FOUCE, for its Spanish acronym) during the period from 2015 to 2019.

MATERIALS AND METHODS

Cross-sectional study with a population made up of clinical records and digital panoramic radiographs of patients who came to the FOUCE's operation room for surgical extraction of inferior third molars during the period from 2015 to 2019, which are kept in the general archive of this faculty. The estimated sample consisted of 424 clinical records with panoramic radiographs according to the following inclusion criteria: clinical records of patients of both sexes and any age who attended for surgery of one or two inferior third molars, systemically healthy, without previous nerve alteration, and with high-quality panoramic radiographs. In addition, as exclusion criteria we considered the clinical records of patients who came for surgery of oral pathologies other than inferior third molars, with other complications that were not due to nerve alteration, or where this had been suffered prior to the surgical intervention, clinical records that were not legible, or with deficient filing without informed consent and/or assent, and with panoramic radiographs that did not present a high-quality image.

After being approved by the Research Committee of the Faculty (COIF, for it Spanish acronym) and authorized by FOUCE's authorities, the selection of clinical records began. The patient's clinical history number and data (age and sex) were registered, and the presence or absence of nerve alterations was verified in the evolution notes. In the panoramic radiographs, the following data were analyzed and recorded: data such as the side of the third molar; the classification according to Pell & Gregory (15), and Winter (16), which categorizes the third molars according to their spatial position in the bone; the Nolla staging (17), which determines the level of development of the permanent teeth; and the presence or absence of radiographic signs predictive of nerve injury according to Rood & Shehab (14), such as root darkening, changes in root direction, root narrowing, root darkening and bifid root, dental canal deviation, dental canal narrowing and interruption of the white line of the dental canal.

The data were recorded in an Excel matrix. Statistical analysis was carried out using SPSS version 25.0, and descriptive statistics were conducted for absolute and relative frequencies. To assess potential associations between nerve alteration and variables such as age, sex, third molar location, Pell & Gregory classification, Winter's position, Nolla stage, and radiographic signs predictive of nerve involvement, the chi-square test was applied with a 95% confidence level ($p < 0.05$).

RESULTS

The estimated sample consisted of 424 clinical records that met the inclusion and exclusion criteria, analyzing 772 third molars in the corresponding digital panoramic radiographs. Of the total of 424 clinical records reviewed, 16 presented nerve alterations, representing 3.8% (table 1).

The female sex presented 5.6% (n = 14) of nerve alteration. The third molar number 38 presented 2.3% (n = 9), and the third molar number 48 presented 1.8% (n = 7). In the Pearson's chi-square test (p-value), the significance level value was 0.016; therefore, the presence of nerve alteration may be influenced by sex (table 2).

Table 1. Frequency of nerve alteration in patients treated in the operating room of the Faculty of Odontology during the period 2015-2019.

Nerve alteration	n	%
Absent	408	96.2
Present	16	3.8
Total	424	100.0

Regarding age, patients between 15 and 19 years old who presented nerve alteration are 1.5% (n = 3); those between 20 and 25 years old, 3.9% (n = 6); and those older than 25 years old, 9.7% (n = 7). Regarding the Nolla staging, stage 7 presented 0.9% (n = 1); stage 8, 1.3% (n = 1); stage 9, 1.8% (n = 2); and stage 10, 3.0% (n = 12). In the Pearson's chi-square test (p-value), the value of the level of significance is 0.007; therefore, there is statistical significance between the variables age and nerve alteration (table 2).

According to the Pell & Gregory classification, type C presented 4.4% (n = 6); and class III, 1.9% (n = 2) of nerve alteration. Winter's mesioangular position presented 2.6% (n = 13); horizontal, 0.9% (n = 1); and vertical; 1.4% (n = 2). In the Pearson's chi-square test (p-value), the significance level value is 0.039; therefore, there is a significant difference between the Pell & Gregory type variables, and the nerve alteration (table 2).

Table 2. Nerve alteration according to the characteristics of patients treated in the operation room of the Faculty of Odontology during the period 2015-2019.

Variable	Nerve alteration				Total		p
	Absent		Present				
	n	%	n	%	n	%	
Sex							
Male	174	98.9	2	1.1	176	100.0	
Female	234	94.4	14	5.6	248	100.0	0.016*
Total	408	96.2	16	3.8	424	100.0	
Third molar							
Left 38	380	97.7	9	2.3	389	100.0	
Right 38	376	98.2	7	1.8	383	100.0	0.636
Total	756	97.9	16	2.1	772	100.0	
Age							
15-19 years old	196	98.5	3	1.5	199	100.0	
20-25 years old	147	96.1	6	3.9	153	100.0	0.007*
>25 years old	65	90.3	7	9.7	72	100.0	
Total	408	96.2	16	3.8	424	100.0	
Nolla staging							
Stage 5	21	100.0	0	0.0	21	100.0	
Stage 6	56	100.0	0	0.0	56	100.0	
Stage 7	108	99.1	1	0.9	109	100.0	
Stage 8	77	98.7	1	1.3	78	100.0	0.494
Stage 9	109	98.2	2	1.8	111	100.0	
Stage 10	385	97.9	12	3.0	397	100.0	
Total	756	97.9	16	2.1	772	100.0	
Pell & Gregory							
Type A	291	99.3	2	0.7	293	100.0	
Type B	334	97.7	8	2.3	342	100.0	0.039*
Type C	131	95.6	6	4.4	137	100.0	
Total	756	97.9	16	2.1	772	100.0	
Class I	120	99.2	1	0.8	121	100.0	
Class II	530	97.6	13	2.4	543	100.0	0.541
Class III	106	98.1	2	1.9	108	100.0	
Total	756	97.9	16	2.1	772	100.0	
Winter							
Mesioangular	480	97.4	13	2.6	493	100.0	
Distoangular	17	100.0	0	0.0	17	100.0	
Horizontal	108	99.1	1	0.9	109	100.0	
Vertical	141	98.6	2	1.4	143	100.0	0.794
Cross-sectional	9	100.0	0	0.0	9	100.0	
Inverted	1	100.0	0	0.0	1	100.0	
Total	756	97.9	16	2.1	772	100.0	

Among the predictive radiographic signs, the variables that showed an association with the prevalence of nerve injury were dark and bifid roots with a value (p-value) of 0.024, interruption of the white line with 0.025, and deviation of the inferior alveolar canal with 0.012 (table 3).

Table 3. Radiographic findings associated with postsurgical nerve alteration in inferior third molar surgery in patients treated in the operation room of the Faculty of Odontology during the period 2015-2019.

Variable	Nerve alteration				Total		p
	Absent		Present				
	n	%	n	%	n	%	
Root darkening	351	98.6	5	1.4	356	100.0	0.228
Root without darkening	405	97.4	11	2.6	416	100.0	
Root deviation	78	100.0	0	0.0	78	100.0	0.175
Root without deviation	678	97.7	16	2.3	694	100.0	
Root narrowing	31	96.9	1	3.1	32	100.0	0.669
Root without narrowing	725	98.0	15	2.0	740	100.0	
Dark and bifid root	21	91.3	2	8.7	23	100.0	0.024*
Without dark and bifid root	735	98.1	14	1.9	749	100.0	
White line interruption	156	95.7	7	4.3	163	100.0	0.025*
Without white line interruption	600	98.5	9	1.5	609	100.0	
Deviation of the inferior alveolar canal	58	93.5	4	6.5	62	100.0	0.012*
Without deviation of the inferior alveolar canal	698	98.3	12	1.7	710	100.0	
Dental canal narrowing	74	98.7	1	1.3	75	100.0	0.636
Without dental canal narrowing	682	97.8	15	2.2	697	100.0	

DISCUSSION

The study determined that the frequency of nerve alteration after mandibular third molar surgeries in patients treated in the FOUCE's operation room during the period 2015-2019 was 3.8%.

Consistent with the results of this research, Gomes et al. (4) found 3.8% of sensorial alteration in a clinical trial in patients treated with local anesthesia. In a study similar to ours, conducted with clinical records of 609 patients treated at the Carlos Andrade Hospital in the city of Quito, a prevalence of nerve injuries of 2.46% was found following the extraction of inferior third molars (18). In a study conducted with 136 patients that underwent a surgical extraction of retained inferior third molars, 3.5% had neurosensory disorders (9), a figure close to that reported by Charan Babu et al. (19) with a 4%. While, in a Korean population of 4708 patients, only 0.658% complained to have had nerve damage (3); and in a study with 12,842 patients, a prevalence of 0.81% nerve alteration was found; however, in other studies, frequencies of 6.4% (21), 12% (22), and 13.2% (23) have been reported. Sarikov & Juodzbalys (24), after analyzing various studies in a bibliographic review, determined that paresthesias appear with a frequency of 0.35 to 8.4%. The great variability in prevalence may be influenced by the criteria considered for the sample selection, or the control of certain factors such as the surgeon's experience, the use of postsurgical medication, subsequent controls, among others.

The results showed that the female sex is mostly associated with nerve alterations. Similar studies confirm that the risk of nerve damage is higher in women compared to men (3, 18, 20, 25, 26), reaching a 5.3 times higher risk in women (27). This is possibly related to the physiological and hormonal changes in women, to the greater neurogenic vulnerability, or to the development of the mandibular bone, generally giving less space for the eruption of the third molar in comparison with the male sex. On the other hand, other studies have published that there is no significant difference between both sexes in relation to the presence of nerve alteration (19, 21).

The hemiarch where the third molar is located, according to this study, is not a relevant factor for the appearance of nerve alteration, since both the right and left sides can present the same proportion of nerve alteration. Studies with these variables also found no significant difference for the relationship between this condition and the location of the third molar (21, 25, 26), being the possible reason that there is no topographic anatomical difference between both sides of the mandible. Whereas Guerra (9) when associating the location of the third molars with the nerve alteration, found that there is predominance on the left side.

Studies linking age to nerve alteration have concluded that the prevalence increases significantly with age (3, 19-21, 24, 26, 27), which is consistent with the results of our study. This is presumably due to more advanced stages in the formation of the third molar, greater bone density, lower capacity for nerve regeneration and higher incidence of associated pathologies.

According to the Pell & Gregory classification, for this study the depth of the third molar influences the presence of postsurgical nerve alteration, taking into account that it is more associated with type C. While for the class no significant difference was found, perhaps because it is related to the horizontal position of the third molar, and not to its depth. Other studies also mention that there is only a relationship between the depth of impaction of the third molar (Pell & Gregory type) and the incidence of nerve injury, more frequently in type C, arguing that the deeper the tooth is, the closer it is to the nerve. This makes its extraction more difficult, thus increasing the possibility of injury (3, 18, 20). Although it has also been mentioned that there is a significant difference for the appearance of nerve alteration in relation to type C and class III according to Pell & Gregory (9, 21).

The position of the third molar, according to Winter, was not a differentiating factor for the appearance of nerve alteration. It is necessary to obtain results with a bigger sample to have better variability of positions, since in this study there were positions with a low percentage. Similar to this result, other studies reported that there was no significant difference in Winter's positions (19-21). However, it was also found that the mesioangular impaction is most frequently found in relation to the inferior dental nerve, causing the greatest amount of nerve alterations (9, 11, 25, 26). Furthermore, Sarikov & Juodzbalys (24) determined that the horizontal impaction may increase the risk of nerve alteration.

Radiographic signs, which by their presence may indicate an increased risk of postsurgical nerve alteration, were dark and bifid root, white line interruption, and alveolar canal deviation. The possible cause of these results is that these signs show a true proximity between the roots of the inferior third molars and the inferior dental nerve. According to Su et al. (28), the canal deviation, the interruption of the canal's white line, and the root darkening can be considered risk signs for postsurgical nerve injury. While Hasegawa et al. (21) found white line interruption and canal deviation as the most predictive signs. In contrast, Kim et al. (20) found root darkening, root deviation, root narrowing, dark and bifid root apexes, and canal narrowing as statistically significant risk factors for cases of nerve alteration. Kim et al. (3) found that root darkening and the alveolar canal deviation can be related to the increased likehood of nerve alterations. For Patel et al. (29), white line interruption, root darkening, root deviation, canal narrowing, and canal deviation are associated with the absence of corticalization between the third molar and the inferior alveolar nerve canal, resulting in postsurgical neurologic complications. Elkhateeb & Awad (30) evaluated the risk relationship between the inferior alveolar nerve and impacted mandibular third molars, finding canal wall disruption, root darkening, and canal narrowing as the most predictive signs. Other authors who also analyzed these variables found that the absence of the radiographic cortical or with line had a significantly higher incidence in nerve injuries (11, 22, 23).

As a limitation of this study, we can mention that the sample could not be homogenous among the groups of variables such as age or sex, since the existing radiographs of patients treated in the operation room of Universidad Central del Ecuador were taken.

CONCLUSIONS

The frequency of nerve alterations following the extraction of mandibular third molars in patients treated at the FOUCE Surgical Center between January 2015 and December 2019 was 3.8%. There was an association between the presence of nerve injury and sex, age and depth of the third molar, according to the Pell & Gregory classification. It was identified that the radiographic signs such as dark and bifid root, white line interruption, and inferior alveolar canal deviation are associated with postsurgical nerve alteration.

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