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Artículos

Relationship Between Lower Third Molars and Mandibular Alveolar Canal through Cone Beam CT Scans*

Relación entre terceros molares y conducto alveolar inferior con tomografías de haz cónico

Relação entre terceiros molares inferiores e canal alveolar mandibular através de tomografias de feixe cônico

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Abstract:

Background: Third molar extractions are considered one of the most common procedures in oral surgery. Well-known complications of these procedures are lesions to the inferior alveolar nerve because of its proximity to the roots of third molars. Hence, it is important to making an adequate assessment of this relationship to avoid complications. **Purpose:** To determine the relationship between the inferior alveolar canal (IAC) retained lower third molars, and that relationship with angulation, class and type of lower third molars through cone-beam computed tomographies. **Methods:** A descriptive and transversal study was conducted with 73 tomographies to 113 lower third molars that were analyzed in the axial, occlusal, and sagittal planes (p = 0.05). **Results:** 54 % of third molars were in contact with the IAC and more frequently in its lower location (45.9 %) (p = 0.000). Proximity relationships were more common on the left side with a vertical angulation (40.6 %), type A (37.5 %), and class II (75 %)(p = 0.015). On the right side, a mesioangular angulation (34.5 %), type A (48.3 %) (p = 0.004), and class II (58.6 %) (p = 0.000) were the most common. **Conclusion:** A close proximity relationship of the IAC with the lower third molars was found using cone beam computed tomography, and it is recommended to conduct a careful diagnosis before a surgical procedure.
Keywords: dentistry, diagnostics, inferior alveolar canal, lower alveolar nerve, oral surgery, proximity, third molar, tomography, tooth extraction.

Resumen:

Antecedentes: La extracción de terceros molares es considerada uno de los procedimientos más comunes en cirugía oral. Complicaciones bien conocidas de estos procedimientos son las lesiones del nervio alveolar inferior por su proximidad a las raíces de los terceros molares. De ahí la importancia de realizar una adecuada valoración de esta relación para evitar complicaciones. **Objetivo:** Determinar la relación entre el canal alveolar inferior (CAI) de terceros molares inferiores retenidos, y esa relación con la angulación, clase y tipo de terceros molares inferiores a través de tomografías computarizadas de haz cónico. **Métodos:** Se realizó un estudio descriptivo y transversal con 73 tomografías de 113 terceros molares inferiores que se analizaron en los planos axial, oclusal y sagital (p = 0,05). **Resultados:** El 54 % de los terceros molares estaba en contacto con el CAI y con mayor frecuencia en su ubicación inferior (45,9 %) (p = 0,000). Las relaciones de proximidad fueron más frecuentes en el lado izquierdo con angulación vertical (40,6 %), tipo A (37,5 %) y clase II (75 %) (p = 0,015). En el lado derecho, la angulación mesioangular (34,5 %), tipo A (48,3 %) (p = 0,004) y clase II (58,6 %) (p = 0,000) fueron las más frecuentes. **Conclusión:** Se encontró una estrecha relación de proximidad del CAI con los terceros molares inferiores mediante tomografía computarizada de haz cónico. Se recomienda realizar un diagnóstico cuidadoso antes de un procedimiento quirúrgico.
Palabras clave: canal alveolar inferior, cirugía oral, diagnóstico, extracción dental, nervio alveolar inferior, odontología, proximidad, tercer molar, tomografía.

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Resumo:

Antecedentes: A extração de terceiros molares é considerada um dos procedimentos mais comuns em cirurgia oral. Complicações bem conhecidas desses procedimentos são as lesões do nervo alveolar inferior devido à sua proximidade com as raízes dos terceiros molares. Portanto, é importante fazer uma avaliação adequada dessa relação para evitar complicações. **Objetivo:** Determinar a relação entre os terceiros molares inferiores retidos no canal alveolar inferior (CAI) e essa relação com a angulação, classe e tipo de terceiros molares inferiores através de tomografias computadorizadas de feixe cônico. **Métodos:** Foi realizado um estudo descritivo e transversal com 73 tomografias de 113 terceiros molares inferiores que foram analisados nos planos axial, oclusal e sagital (p = 0,05). **Resultados:** 54 % dos terceiros molares estavam em contato com o CIA e mais frequentemente em sua localização inferior (45,9 %) (p = 0,000). As relações de proximidade foram mais comuns no lado esquerdo com angulação vertical (40,6 %), tipo A (37,5 %) e classe II (75 %) (p = 0,015). No lado direito, a angulação mesioangular (34,5 %), tipo A (48,3 %) (p = 0,004) e classe II (58,6 %) (p = 0,000) foram as mais comuns. **Conclusão:** Uma relação de proximidade do CAI com os terceiros molares inferiores foi encontrada na tomografia computadorizada de feixe cônico, sendo recomendado um diagnóstico criterioso antes de um procedimento cirúrgico.

Palavras-chave: canal alveolar inferior, cirurgia oral, diagnóstico, extração de dente, nervo alveolar inferior, odontologia, proximidade, terceiro molar, tomografia.

INTRODUCTION

One of the most common procedures performed in oral surgery is the extraction of third molars, which are frequently retained (1,2). A common complication during enucleation of third molars is injury to the inferior alveolar nerve, the incidence rate of which ranges from 1% to 22%. Such complications occur due to the proximity between these structures, hence the importance of performing an adequate imaging examination before these procedures to determine if there is an intimate relationship between these structures (3,4,5).

The various procedures performed on the mandible require detailed knowledge of the position and trajectory of the inferior alveolar canal (IAC), which contains the inferior alveolar neurovascular bundle within it. A lack of knowledge of the anatomical relationships of the IAC in surgical procedures can cause lacerations, compression, or even sever the nerve, generating nerve injuries such as neuropraxia, axonotmesis, or neurotmesis (6). This type of injury can also affect the success of procedures and cause pain, discomfort, and dissatisfaction in patients, which can complicate or prolong recovery (7).

Third molar impactions are often associated with various complications such as pain on eruption, pain on chewing, root caries in second molars, and pericoronitis. For this reason, sometimes, in order to avoid foreseeable problems with these molars, a prophylactic extraction is chosen (7,8).

One of the most used preoperative exams as a standard diagnosis due to its accessibility, cost, and technique are panoramic radiographs. Such radiographs may show some indicators to determine the relationship between the lower third molars and the IAC. Among these indicators are the interruption of the radiopaque line of the IAC, the deviation or change of direction of this canal and the narrowing in relation to the apices of the third molar. These radiographic signs could serve for a pre-surgical evaluation of the risk of any possible sensory injury after surgical extraction of these molars (9,10). However, radiography, despite its usefulness, has the disadvantages that it produces two-dimensional images of three-dimensional structures, some blurred areas, lack of sharpness, and image overlap, which will make it difficult to determine the exact relationship between the lower third molars and the IAC (11).

The introduction of cone-beam computed tomography has been a great diagnostic aid as it creates multiplanar good-quality images, excellent geometric accuracy, and no overlaps, as is the case with panoramic radiographs (9). In oral surgery, it began to be used as a diagnostic tool to evaluate the proximity between the third molar and the IAC and thus avoid injury to the inferior alveolar nerve during surgical extraction. However, its use has been relegated to cases in which the proximity of the third molar to the IAC has been established by means of panoramic radiography, not as a standard study that could reveal not only said

proximity, but also provide other findings such as variants. anatomical characteristics of the canal, position of the vestibular, lingual and inferior nerves, and the shape of the apices (12).

Worldwide, there is an increasing trend in the incidence of impacted third molars. Studies on the evolution of the surgical process describe that there is greater retention of these teeth in young people, with a greater impact on the mandibular lower left quadrant. According to morbidity data obtained from the Ministry of Public Health of Ecuador, an annual increase in patients treated for complications secondary to the presence of third molars included in the mandible is reported (13). These data have more impact in places like Quito, a city that hosts more than 53 % of internal migration from Ecuador and in which different ethnic groups coexist: Mestizos, Whites, Afro-descendants, Indigenous, and Montubios (14), which widen the anatomical variations in relationship with the third molars and the IAC. The present study was conducted in order to determine the relationship between the IAC and retained lower third molars through cone beam computed tomography of patients who were candidates for surgical extraction of third molars who attended the Xplora DEIM Radiology Service in the city of Quito.

MATERIALS AND METHODS

A descriptive and cross-sectional study was carried out that obtained the approval of the Research Ethics Subcommittee of the Central University of Ecuador, code SIB-ICE 25-06-2018, and the authorization of the director of the Xplora DEIM Radiology Center for access to the imaging database. We sought to determine the relationship between the lower third molars retained with the IAC, through the use of cone-beam computed tomography obtained in the period from January 2017 to March 2018.

The study included the CT scans of patients of both sexes, from 18 to 70 years of age, who attended the Radiology Center with orders for panoramic radiographs for the extraction of lower third molars in Nolla stage 9 (almost complete root with apex open) onward (15). X-rays of patients who presented supernumerary teeth, pathological entities in the region of the third molars, and who were in Nolla stage of 8 or less in the third molars were excluded from the study.

The tomographic images used for the investigation were made in a Hyperion X9® tomographic equipment that has a minimum voxel size of 750 μm, with a field of view of 11x5 (lower jaw), 11x8 (bimaxillary) and 11x13 (full face). The images were evaluated using MyRay's iRYS® program, which consists of advanced desktop software for oral and maxillofacial image analysis with image archiving and processing functions. It is used with keyboard and mouse on a desktop computer with a Windows 10 Pro® 64-bit operating system, Intel Core 2 duo® processor and a monitor with a minimum resolution of 1280 x 1024 pixels.

The observation of the structures was conducted through visual inspection of the tomography in adequate conditions of physical space and ventilation, with dim ambient light and silence for interpretation (7). The imaging evaluation sessions were carried out in the morning hours, considering visual breaks from time to time working on the computer. All data and variables were duly recorded on registration forms.

The study had a total of 90 cone beam computed tomography scans of which 73 met the inclusion and exclusion criteria. For the analysis of each tomography in the 3D panoramic view, the hemiarch of each third molar was first identified. Then, the class, type and angulation were determined, based on what was proposed by Winter, and Pell and Gregory (5,16-17) (figures 1 and 2). These variables allow the oral surgeon to determine the spatial position of the third molar with respect to the second molar and the mandibular ramus and thus anticipate a possible difficulty in its extraction.

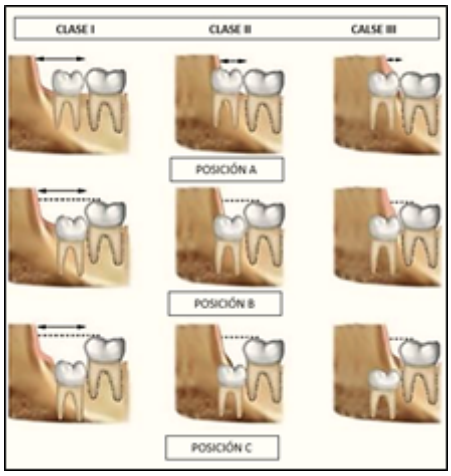

FIGURE 1
Pell and Gregory Classification for Lower Third Molars (5,16-17)
Elaborated by: the authors.

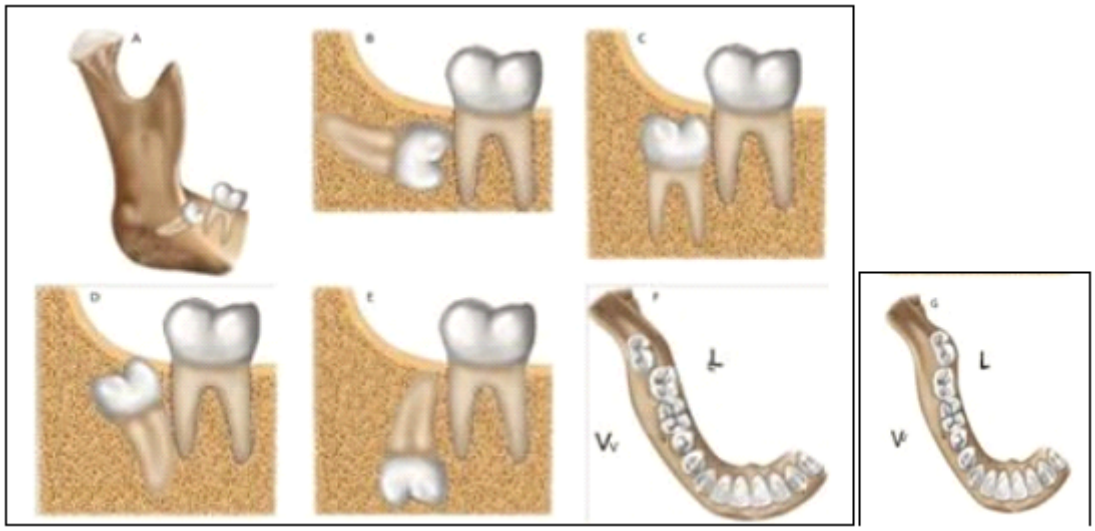

FIGURE 2
Winter's classification for lower third molars: A: mesioangular, B: horizontal, C: vertical, D: distoangular, E: inverted, F: vestibuloversion, G: linguoversion (15,16-17)
Elaborated by: the authors.

In the different axial, coronal, and sagittal anatomical slices with a thickness of 0.3 mm (reference measure of several studies reviewed), the image gradually moved until the relationship of proximity existing between the IAC cortical and the lower third molar, to then assess the contact or not between these structures and the position of the canal: lower, lingual, buccal, or interradicular (18) (figure 3). In cases where no contact was found, after aligning the coronal and sagittal planes with the long axis of each root, the shortest distance from the tip of the root apex surface to the nearest outer surface of the IAC cortical limit was measured.

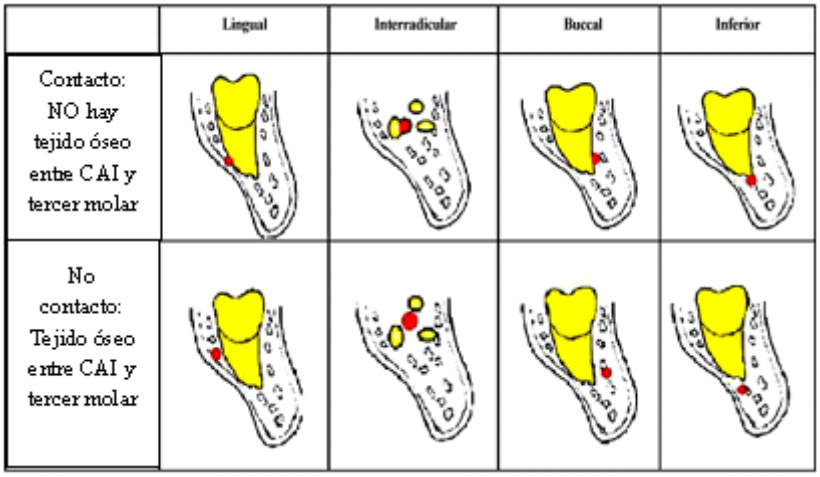

FIGURE 3
Classification of the position and relationship between the roots of third molars and the IAC as seen on cone beam computed tomography
Elaborated by: the authors.

The observer's calibration was performed with a maxillofacial radiology specialist regarding the analysis and evaluation of the tomography to determine the relationship of proximity, location, and distance between the IAC and the lower third molars. The Kappa test was used, based on the comparison of opinions, judgments, or results issued or obtained by different subjects, which showed a concordance greater than 0.78, which is considered very good. Descriptive and frequency statistics were used to analyze the relationships of the roots to the CAI, angulation, type, and class of the third molars with respect to the CAI, as well as the relationships between gender, age, and proximity of the third molar. Independent t-tests were also used to compare these variables. To analyze the relationship between variables of proximity and location of the IAC with the lower third molars, the Pearson Chi-square test was used. All data was included in the statistical program IBM® SPSS® 22.

RESULTS

Among the 73 cone-beam computed tomography scans obtained, 113 lower third molars were found, of which 32 were male patients and 41 female patients. There were 49 third molars on the left side and 64 on the right side. A total of 61 (54 %) lower third molars were in direct contact with the IAC and 52 were not. Among the third molars in relation to the IAC, the lower location was more frequent in 45.9 % of the cases ($p = 0.000$) (Table 1) (Figures 4-5).

TABLE 1
Relationship between Proximity and Location

Location		Proximity		Total
		Contact	N contact	
Lingual	Count	20	1	21
	Percentage	32 .8	1 .9	18 .6
Vestibular	Count	12	16	28
	Percentage	19 .7	30 .8	24 .8
Inferior	Count	28	35	63
	Percentage	45 .9	67 .3	55 .8
Interradicular	Count	1	0	1
	Percentage	1 .6	0 .0	0 .9
Total	Count	61	52	113
	Percentage	100 .0	100 .0	100 .0

Elaborated by: the authors.

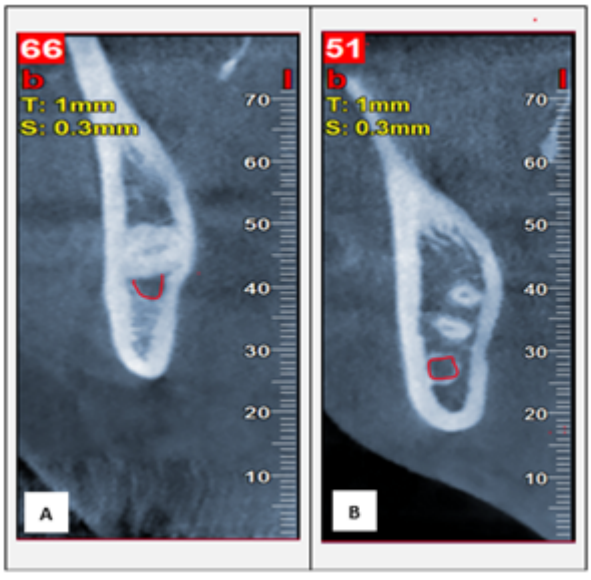

FIGURE 4
Proximity Relationship Between the Mandibular Third Molars and the IAC A: contact relationship. B: no contact
Elaborated by: the authors.

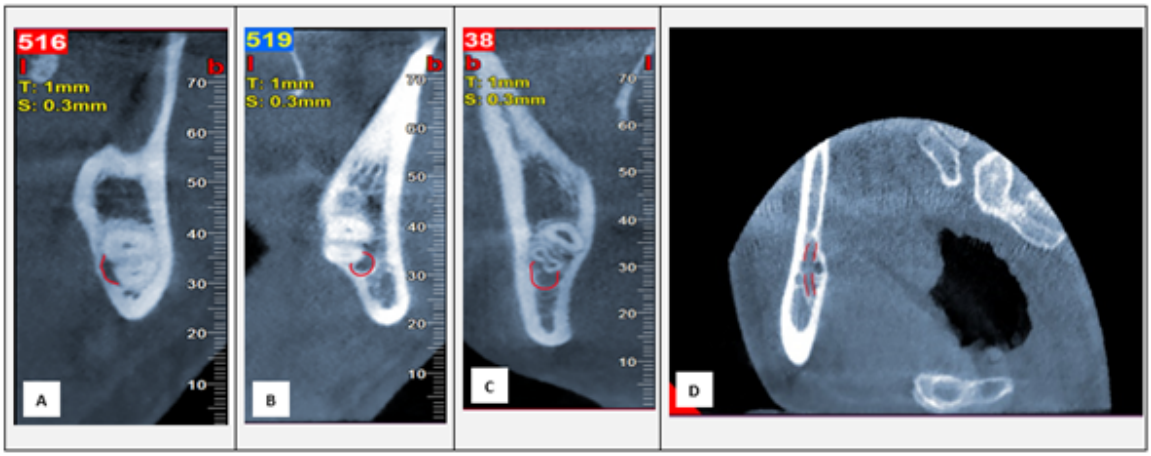

FIGURE 6
Location Relationship of the IAC With Respect To the Roots of the Mandibular Third Molars.
A: lingual. B: vestibular. C: bottom. D: interradicular
Elaborated by: the authors.

In the third molars on the left side in contact with the IAC, with respect to angulation, the vertical position was more representative (40.6 %). Regarding the type, the most common was type A (37.5 %). On the other hand, class II was the most frequent (75%) (p = 0.015) (Table 2).

Regarding the third molars on the right side in contact with the IAC, in relation to the angulation, the mesioangular position was more frequent (34.5 %) (p = 0.05). Also, type A was the most common (48.3 %) (p = 0.004) and so class II (58.6 %) (p = 0.000) (Table 3).

TABLE 2
Relationship Between Proximity and Angulation, Class and Type Classification of Lower Third Molars on the Left Side

Variable			Proximity		Total	p
			Contact	No Contact		
Angulation	Mesioangular	Count	9	6	15	0.788
		Percentage	28.10	35.30	30.60	
	Distoangular	Count	1	1	2	
		Percentage	3.10	5.90	4.10	
	Vertical	Count	13	8	21	
		Percentage	40.60	47.10	42.90	
	Horizontal	Count	5	1	6	
		Percentage	15.60	5.90	12.20	
	Vestibuloversion or Bucoangular	Count	2	0	2	
		Percentage	6.30	0.00	4.10	
	Linguoversion or Linguoangular	Count	2	1	3	
		Percentage	6.30	5.90	6.10	
Type	A	Count	12	12	24	0.087
		Percentage	37.50	70.60	49.00	
	B	Count	11	3	14	
		Percentage	34.40	17.60	28.60	
	C	Count	9	2	11	
		Percentage	28.10	11.80	22.40	
Class	I	Count	4	8	12	0.015
		Percentage	12.50	47.10	24.50	
	II	Count	24	9	33	
		Percentage	75.00	52.90	67.30	
	III	Count	4	0	4	
		Percentage	12.50	0.00	8.20	

Elaborated by: the authors.

TABLE 3
Relationship Between Proximity and Angulation, Class and Type Classification of Lower Third Molars on the Right Side

Variable			Proximity		Total	p
			Contact	No Contact		
Angulation	Mesioangular	Count	10	8	18	0.054
		Percentage	34.50	22.90	28.10	
	Distoangular	Count	1	3	4	
		Percentage	3.40	8.60	6.30	
	Vertical	Count	8	20	28	
		Percentage	27.60	57.10	43.80	
	Horizontal	Count	5	2	7	
		Percentage	17.20	5.70	10.90	
	Vestibuloversion or Buc angular	Count	0	1	1	
		Percentage	0.00	2.90	1.60	
	Linguoversion or Linguoangular	Count	5	1	6	
		Percentage	17.20	2.90	9.40	
Type	A	Count	14	30	44	0.004
		Percentage	48.30	85.70	68.80	
	B	Count	9	4	13	
		Percentage	31.00	11.40	20.30	
	C	Count	6	1	7	
		Percentage	20.70	2.90	10.90	
Class	I	Count	6	22	28	0.000
		Percentage	20.70	62.90	43.80	
	II	Count	17	13	30	
		Percentage	58.60	37.10	46.90	
	III	Count	6	0	6	
		Percentage	20.70	0.00	9.40	

Elaborated by: the authors.

In the cases where there was no proximity, distances were between 0.3 mm (minimum) and 5 mm (maximum). The average of the distance was 1.03 mm (Tables 4 and 5).

TABLE 4
Distances Found on the Left Side

Distance (mm)		Proximity		Total
		Contact	No contact	
0.0	Count	32	0	32
	Percentage	100.00	0.00	65.30
0.1-1.4	Count	0	7	7
	Percentage	0.00	41.20	14.30
1.5-2.5	Count	0	7	7
	Percentage	0.00	41.20	14.30
2.6-4.0	Count	0	3	3
	Percentage	0.00	17.60	6.10
Total	Count	32	17	49
	Percentage	100.00	100.00	100.00

Elaborated by: the authors.

TABLE 5
Distances Found on the Right Side

Distance (mm)		Proximity		Total
		Contact	No Contact	
0.0	Count	29	0	29
	Percentage	100.00	0.00	45.30
0.1-1.4	Count	0	16	16
	Percentage	0.00	45.70	25.00
1.5-2.5	Count	0	6	6
	Percentage	0.00	17.10	9.40
2.6-4.0	Count	0	8	8
	Percentage	0.00	22.90	12.50
Total	Count	0	5	5
	Percentage	0.00	14.30	7.80

Elaborated by: the authors.

DISCUSSION

In the present study, when evaluating 113 third molars in 73 cone-beam computed tomography scans, 54 % of the cases were in direct contact with the IAC. This frequency is similar to that described in other studies, such as the one by Maglione, *et al*. (1) in Italy, who, when evaluating 133 third molars, found that 69.17 % were in intimate contact with the IAC. Likewise, Herrera Mujica, *et al.* (7), when analyzing 112 mandibular third molars in CT scans, found 65.2 % in contact relationship. Another study by Kursun, *et al*. (19) in Turkey, after evaluating 180 third molars, found a contact relationship with the IAC of 57.8 % cases. An investigation carried out in Peru, by Miranda Barrueto (20), when studying 117 third molars, found that 44.44 % were in contact with the IAC. In South Korea, Kim, *et al*. (21) observed 61 % mandibular third molars in contact with the IAC. In contrast, the findings of this study differ from those of investigations such as that of Shujaat, *et al*. (22) in Saudi Arabia, who evaluated the position of 100 third molars and found that 96 % were in contact with the canal. Ghaeminia, *et al*. (18), in their study conducted in the Netherlands, found contact in 84.9 % of 53 third molars.

Regarding location, it was observed that the contact relationship occurred more frequently in the lower location of the dental canal in 45.9 % of the cases, which was statistically significant ($p = 0.000$). These findings are similar to those described by Maglione, *et al*. (1), for whom the most frequent location was the lower one in 63 % of the cases, and Ye, *et al.* (23), who observed the third molar mostly on the IAC (55.43 %). These findings differ from those of Shujaat, *et al*. (22), since in 77.1 % of their analyzed cases the IAC was located at the lower lingual level. Similarly, Kursun, *et al*. (19) identified 51.7 % of cases of IAC located lingually, although they did not discriminate between contact and non-contact. A third study by Ghaeminia, *et al*. (18) determined a higher frequency of contact of the third molar with the lingual location of the IAC (57.8 %). These data are especially important for the surgeon when deciding the shape and direction of the odontosection and osteotomy.

In the present study, the proximity of the IAC with respect to the angulation, class, and type of the lower third molars was assessed. On the left side, with respect to angulation, vertical angulation was more frequent (40.6 %) and for the right side, mesioangular (34.5 %). This is similar to that described by Bareiro and Duarte (16), who more frequently observed vertical angulation on the left side and mesioangular on the right side with respect to the IAC.

Regarding the type, both on the left and right sides, type A was the most representative with 37.5 % and 48.3 %, respectively. These results are similar to those of Bareiro and Duarte (16), for type A on the left side (50.7 %) but differ on the right side in which type B was the most frequent (50.7 %). Regarding the class, for the left and right sides, the most common was class II, with 75 % and 58.6 %, respectively. Comparing these findings again with those of Bareiro and Duarte (16), class II was the most frequent for right and left molars (58.7 % and 50.7 %, respectively). The results of a study carried out by Sangoquiza Nacimba and Lanas (5) differ with those of the present investigation, since they determined that inferior alveolar nerve damage is associated with Pell and Gregory class III; they state that the risk of nerve injury increases in deeper third molars. However, for a right-handed operator, the left side always represents a challenge for indirect observation and for the difficulty of accessing the instruments, which can complicate the extraction of even type A and class I teeth in a vertical position.

The distances found in the cases where there was no contact range from 0.3 mm to 5 mm, with an average value of 1.03 mm. On the left side, it was found more commonly in the range of 0.1-1.4 mm and 1.5-2.5 mm, in 41.2 % of the cases for each one. For the right side, the range of 0.1-1.4 mm was observed in 45.7 % of the cases. In a study conducted by González, *et al*. (24), in which they evaluated the distance between the lower third molar and the IAC, determined that in a greater percentage the canal was in a range of 1.5-2.5 mm (64 %), which is similar to what was found for the left side of the present study. Calderon, *et al*. (25) identified an average measurement from the IAC to the most apical part of the third molar of 0.7 mm, while Albornoz-

Afanasiev, *et al*. (26) and Yilmaz, *et al*. (27) found an average distance for the left hemiarch of 2.15-2.18 mm and for the right hemiarch of 2.13-2.16 mm, respectively.

Regarding gender, there were no significant differences in the distribution of proximity and location in the groups of men and women ($p = 0.697$). Neither were there in relation to the age group ($p = 0.986$). These results differ from those found by Zain-Alabdeen, *et al*. (3), who concluded that older patients had significantly higher root vertical means relative to IAC, compared to the younger age group.

CONCLUSIONS AND RECOMMENDATIONS

The results of this study show that there is an important relationship of proximity between the IAC and the roots of the third molars included among the patients who attended the Xplora Radiological Center in the city of Quito, Ecuador.

The lower location of the canal was the most frequent, which is why it is suggested to always indicate a complete imaging study prior to the enucleation of mandibular third molars.

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Notes

* Original research.

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