The Different Relations of the Lower Third Molar to the Inferior Alveolar Canal in A Sample of Egyptian Population as Detected by Multislice Computed Tomography (MSCT) and Cone Beam Computed Tomography (CBCT)

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Abstract: Iatrogenic injuries to the nerve can result in a series of dramatic events to the patient due to altered sensation and pain. This can be prevented by an accurate preoperative detection of the inferior alveolar nerve (IAN) location. 3-dimentional evaluation is more advantageous than the 2-dimentional methods. Objective: the aim of the present study was to investigate the frequency of the different relations of the lower third molar to the inferior alveolar canal (IAC). Materials and methods: the different relations were evaluated in 31 cases imaged using multislice computed tomography (MSCT) or cone beam computed tomography (CBCT). This was assessed in a sample of Egyptians. Results: 32.2% of cases showed the canal to be in contact with root, while they were separated in 67.7% of the cases. The canal could be buccal or lingual, inferior or superior or passing through the root and the percentage of these relations were found to be 51.6%, 3.2%, 67.7%, 3.2% and 0% respectively. The canal was found to be at the same level with the root in horizontal direction in 3.2% of cases and in the vertical direction in19.3% of cases. Conclusion: wide range of variation between the percentages of relations reported in literature was observed. This could be attributed to the nature of the studies and the criteria of cases selection. More research is needed to investigate the effects of race and gender on the anatomical location of the inferior alveolar canal.
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1. Introduction

The relation of the lower third molar to the IAC and hence the IAN remains to be an important diagnostic issue. Iatrogenic injuries to the nerve can result in a series of dramatic events to the patient due to altered sensation and pain. This can be prevented by an accurate preoperative detection of the IAN location. Anatomic variations between individuals exist and can be influenced by the race and genetic background.

The IAN is at risk from a variety of dental procedures including local anesthetic injections, third molar surgery, implants, endodontics, ablative surgery, trauma, and orthognathic surgery. Third molar surgery-related inferior alveolar nerve injury is reported to be the 2nd iatrogenic cause (1, 2, 3, 4, 5). The overall risk of temporary IAN injury associated with third molar removal ranges from 0.4% to 6%. The reported rate of permanent IAN injury, in which the sensory impairment lasts longer than 6 months, is less than 1%. The overall risk of permanent impairment during third molar removal is low, but a significant number of patients are affected because many third molars are removed (2, 3, 6). The risk of temporary IAN injury increases, when a close relationship between the third molar and the IAC is observed radiographically (3, 7). Because complications associated with third molar surgery are severe, it is important to assess the position, and establish the relationship, of the third molar with the IAC preoperatively to minimize the risk of nerve injury (8, 9, 10).

Intraoral and panoramic radiographs taken at different vertical angulations have high potential for detecting the closeness between the third molar root and the IAN (4). However experienced oral and maxillofacial surgeons reported that a dependence on a panoramic radiograph alone was unreliable (1). The proximity, angulations, and locations of impacted teeth, related to the IAN, can be difficult to adequately determine using conventional 2-dimensional periapical and panoramic radiographs (11).

Spiral CT is useful for observing the relationship of the tooth and IAC. However, spiral CT necessitates the administration of a high dose of radiation, especially when the slice width is shortened to obtain more accurate data, the radiation dose increases further. Dental 3D-CT has an advantage in this regard (12). There is increasing evidence that CBCT scanning of high risk teeth will further establish the relationship between the IAN and the roots. In many cases the CBCT re-affirms the proximal relationship, however, in a few incidences, despite high risk identification based on plain films, some IANs are found to be distant from the roots using CBCT (5). Compared with panoramic images, CBCT images could be a great tool in predicting neurovascular bundle injury during extraction of impacted lower third molar (10, 12, 13).

Therefore the aim of the present study was to investigate the frequency of the different relations of the lower third molar to the IAC using MSCT and CBCT as diagnostic tools. This was assessed in a sample of Egyptians.

2. Materials and methods:

The present study was performed as a retrospective analysis of data stored in the Diagnostic Radiology Department, Faculty of Medicine, Cairo University and a private radiology center in Egypt. Out of respect of doctor patient confidentiality all personal information concerning the patients as well as the diagnostic cause of the MSCT or CBCT scan were hidden. 45 scans were evaluated (15 CBCT scans and 30 MSCT scans). 31 scans of them were selected to be included in the study. The selection was based on presence of the lower third molar with good visualization of the root tips and absence of any attached pathology or any bone deformity. All patients had the Egyptian nationality.

MSCT scanning:

The examinations were performed using Light Speed® (General Electric, Milwaukee, USA). All images were taken while patients were in prone position. A lateral scanogram was obtained with helical adjustment perpendicular to the long axis of the tooth. The following scan parameters were used for all patients; slice thickness, 1.25mm, at 120kV and 240mA using table speed 1.25 and pitch 1. Bone reconstruction algorithm was used for optimum visualization of the anatomical landmarks.

CBCT scanning:

Images were acquired using the i-CAT Imaging system (Next Generation, Imaging Sciences International, Hatfield, USA) .The patients were exposed in the sitting position and immobilized using a head band to adjust the head against the head rest and chin cup. The mid-sagittal plane was aligned to be perpendicular to the horizontal plane using vertical and horizontal alignment beams as recommended by the manufacturer. The i-CAT is equipped with an amorphous Silicon Flat Panel and a single 360 degrees scan collects the projection data for reconstruction. The X-ray field size applied was 16 cm diameter x 13 cm height, and scanning time was 8.9 seconds (fast enough to avoid patient movement, image blurring and haziness). Operating parameters were 120 kVp, and 5 mA with slice thickness of 0.3 mm (the standard resolution for scanning at i-CAT machine). The i-CATs Vision software (Imaging Sciences International) was used.

Image analysis:

The relation of the third molar and proximity of its apices to the IAC were visually assessed according to the following criteria (figure 1):

Relationship of the canal to the root apices:

1. Root and canal separated
2. Root and canal in contact

Location of the canal to the root apices:

1. Buccal location
2. Lingual location
3. Inferior to the root
4. Superior to the root
5. Passing through the roots

Level of the canal to the root apices:

1. Canal at the same level horizontally
2. Canal at the same level vertically

According to this the canal can have three relations to the root

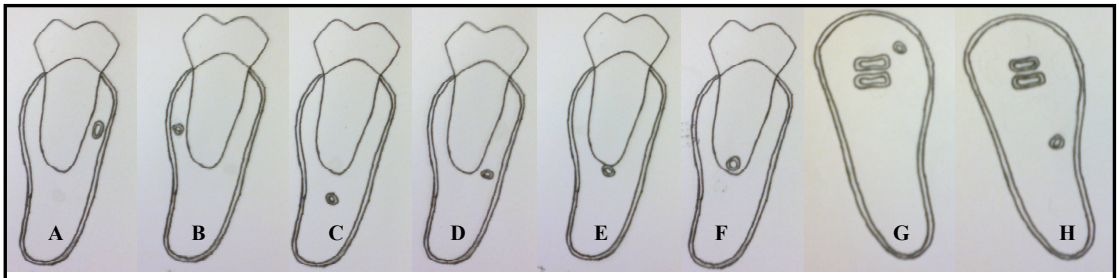

Fig. 1: A diagram showing different possible relations of the mandibular canal with lower third molar where the canal appears either (A) buccal to the roots, (B) lingual to the roots, (C) in line with apex vertically, (D) in line with apex horizontally, (E) in contact with the roots (no bone tissue in between), (F) passing through the roots, (G) superior to roots, and (H) inferior to the roots.

3. Results:

The different relations reported in this study are summarized in table 1 and figure 2. Figures 3 to 6 show images representing the relations investigated in the study.

Table 1: The frequency of occurrence of the different relations of the IAC to the lower third molar as a percentage of the total number of cases (n)

	CT	CBCT	Total	Percentage (n= 31)
Root in contact with canal	8	2	10	32.2%
Root not in contact with canal	11	10	21	67.7%
Canal buccal to the root	8	8	16	51.6%
Canal lingual to the root	0	1	1	3.2%
Canal inferior to the root	10	11	21	67.7%
Canal superior to the root	1	0	1	3.2%
Canal passing through the root	0	0	0	0%
Canal at same level with root tip H	0	1	1	3.2%
Canal at same level with root tip V	3	3	6	19.3%

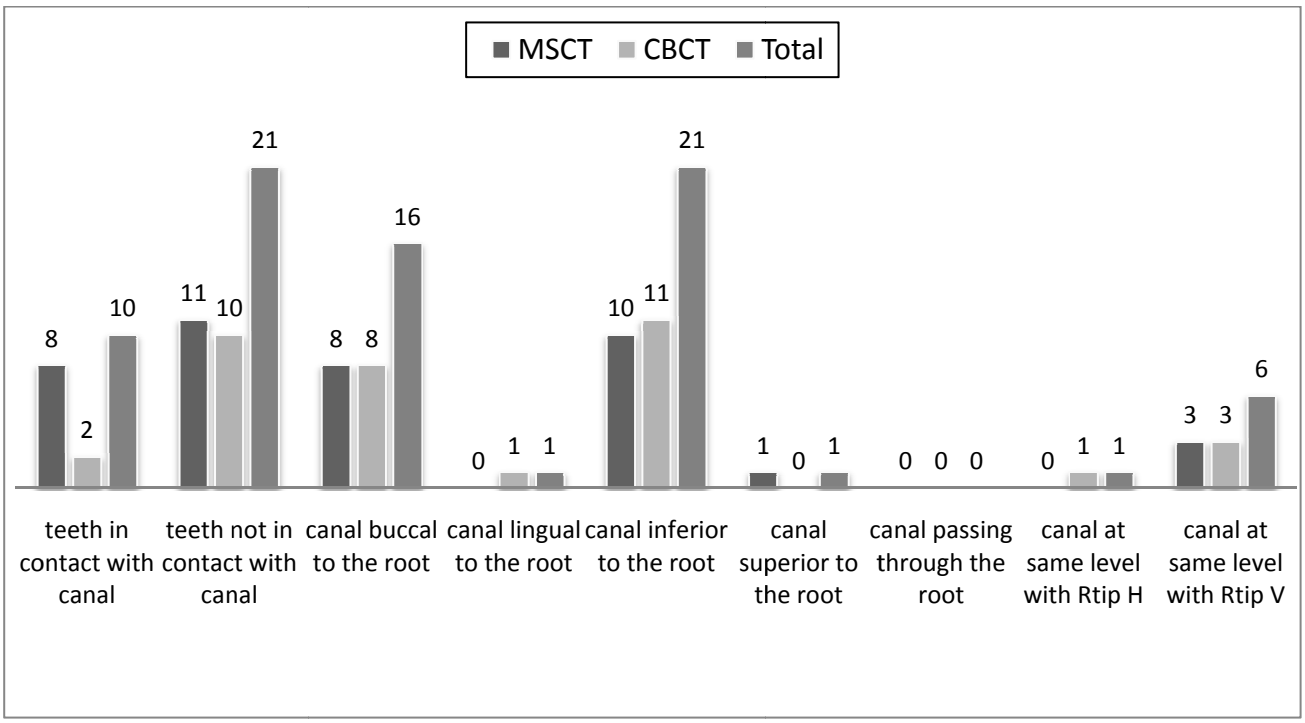

Figure 2: Bar chart showing the frequency of relations of the lower third molar to the IAC.

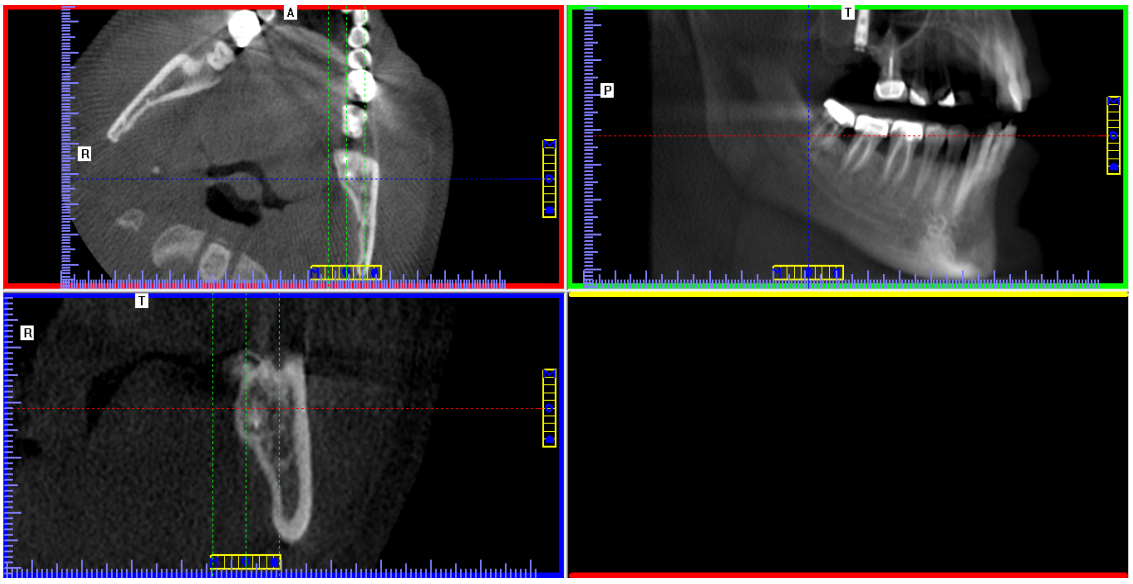

Figure 3: Snap shot of a CBCT scan showing the relation of the IAC to the lower third molar root tip as separated, inferior and buccal to the root (upper left = axial cut, upper right = corrected sagittal cut, lower left = corrected coronal cut).

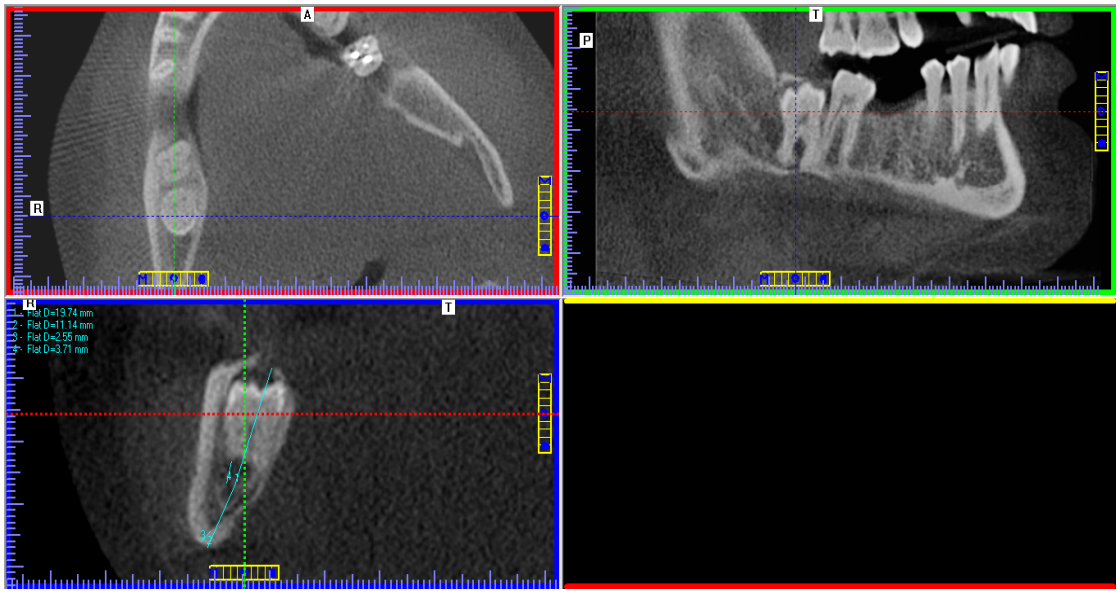

Figure 4: Snap shot of a CBCT scan showing the relation of the impacted lower third molar root tip to the IAC as in contact and at the same level vertically (upper left = axial cut, upper right = corrected sagittal cut, lower left = corrected coronal cut).

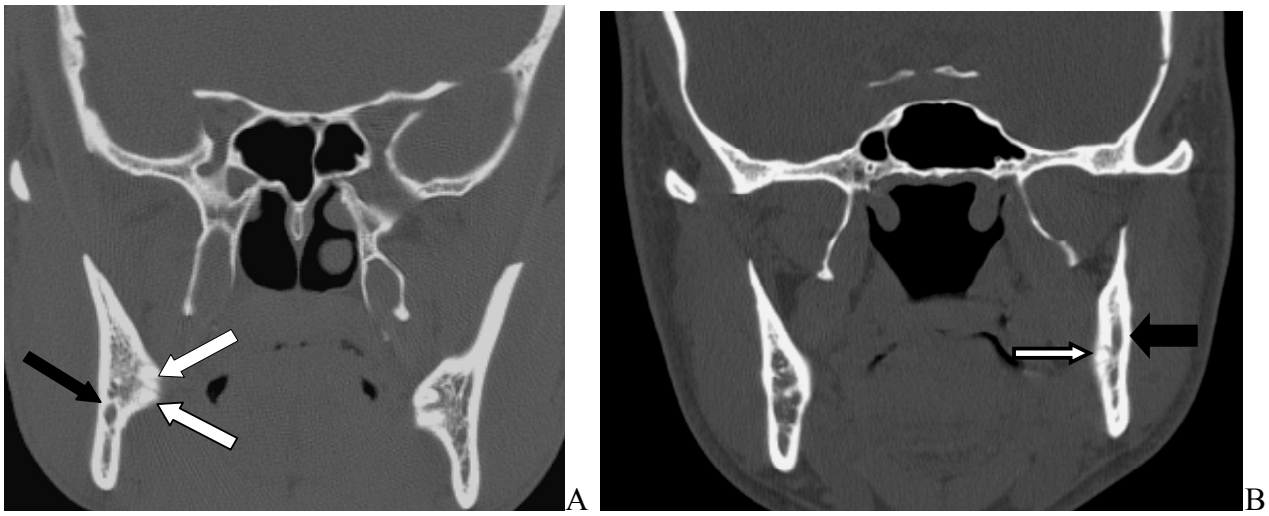

Figure 5: Direct coronal CT images showing the inferior alveolar canal (black arrows) as separated from the root of the lower third molar (white arrows). (A) inferior and buccal; (B) superior and buccal.

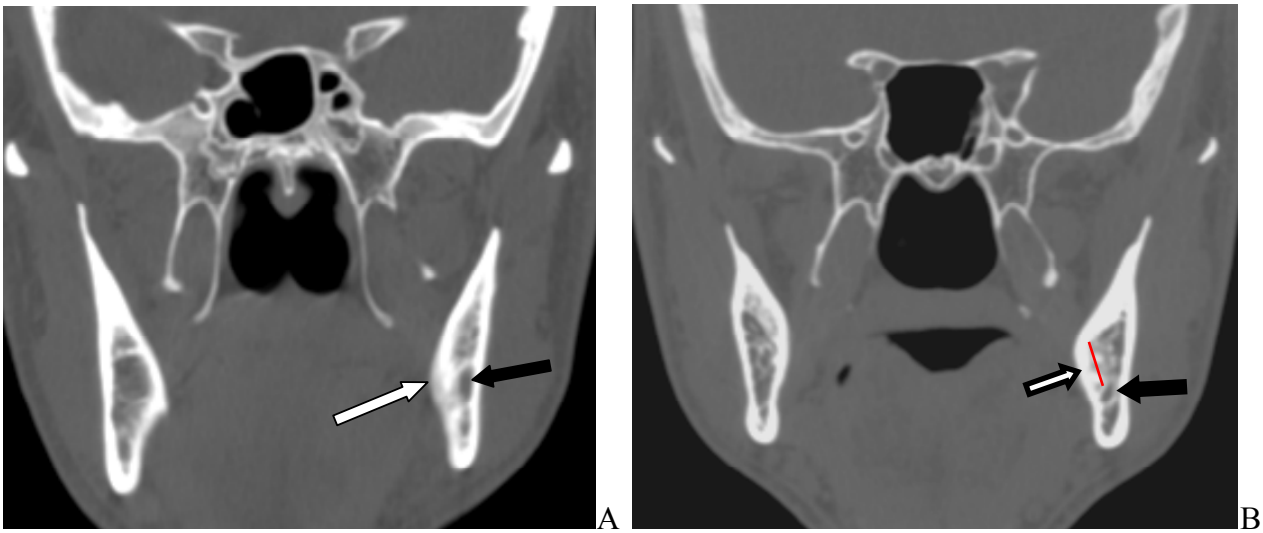

Figure 6: Direct coronal CT images showing the IAC (black arrows) in contact with the root of the lower third molar (white arrows). (A) buccal and at same level horizontally; (B) inferior and the same level vertically (line of connection parallel to lingual plate of bone).

4. Discussion

Avoiding iatrogenic injury of the IAC and hence the IAN depends not only on the experience of the surgeon but largely on the preoperative assessment of the anatomic location of the canal especially its relation to the roots of the third molar. Anatomic variations between individuals exist and can be influenced by the race and genetic background.

Prevention of IAN injury should be based on a thorough understanding of the anatomy in addition to radiographic interpretation (4). Considering that the reported overall incidence of IAN injury secondary to third molar removal ranges varies, it can be helpful for the surgeon, who has a question about the preoperative position of a mandibular third molar, as it relates to the IAC, to visualize that relation in 3 dimensions (11).

In this study, the frequency of different relations of lower third molar to the IAC was assessed using MSCT and CBCT. The survey was retrospectively performed on a sample of Egyptian population. The first detected finding was the prevalence of root tip not in contact with the canal; about two third of the cases (67.7%). Different results were reported by other authors whose studies were done to detect particularly the relation of the third molar teeth with risk of intimate contact with the IAC. Yamada et al.

(10) showed the nearest results among these authors where 57.7% of teeth showed close contact with the canal. On the other hand, both **Ghaeminia et al. (3)** and **Kositbowornchai et al. (4)** reported results that were far away from the results found by this study, where the former reported that 84.9% of teeth showed close contact with the canal while the later reported that the percentage was 71.8%. Such discrepancy in results may be attributed to the nature of teeth selected in such studies, which were focused on teeth showing risk of close contact with the canal as the main target.

Regarding the bucco-lingual position of the canal in relation to the third molar teeth, our study showed that 51.6% of the cases appears buccal to the third molar teeth, while only 3.2% showed a lingual position. Such findings agree with most published articles (4, 10, 14, 15, 16, 17, 18). **Maegawa et al. (16)** showed the nearest results to this study with a percentage of buccal relation of the canal reaching 51% however the percentage of lingual relation was 26%. **Kositbowornchai et al. (4)** reported that 43. 7% of the cases showed buccal relation to the third molar teeth while only 6.3% appeared lingual. **Yamada et al. (10)** also meets our results in that the prevalence of buccal position was higher than that of the lingual but with different percentages, where the canals appearing in buccal position represent 40.2 % of the cases, while those located lingual showed 23.3% of the cases. Again the current study showed different results from those of **Ghaeminia et al. (3),** whose study reported that 49% of the cases showed lingual relation while 17% of the cases showed buccal relation to the third molars.

Another relation of the canal that was also included in this study was its location in-line with the root of the third molar teeth, where 19.3% of cases were located at the same level with the roots in the vertical plane, while only 3.2% of cases appeared at the same level with the roots in the horizontal plane. Such findings didn't meet those reported by the studies that involved the same relation of the canal with the roots only in the vertical plane. **Yamada et al. (10)** mentioned that 36.6% of the cases in their study were in-line with the root of third molar roots, while **Kositbowornchai et al. (4)** reported that this relation represented half the cases.

Other locations of the canal that were reported in this study were the superior-inferior position of the canal in relation to the third molar root and the position the canal as passing through the roots of the third molar (inter-radicular location of the canal). The superior location was reported in only one case, which represented 3.2% of the total cases, the inferior location represented 67.7% of the cases, while the inter-radicular relation was not reported in this study at all. Such locations were not always included in other studies. The inferior relation was more frequently investigated than the superior one, where its percentage ranged from 51% (18) to 16% (17). In the study performed by **Ghaeminia et al. (3)** the inter-radicular location of the canal was reported in 15% of the whole cases while **Maegawa et al. (16)** showed a result of 4%.

This wide range of variation could be attributed to the nature of the studies and the criteria of cases selection. To the authors' knowledge there were no results that were related to a certain race or nationality. Also there was no reference to the effect of gender on the results. Therefore more research is needed to investigate the effects of race and gender on the anatomical location of the inferior alveolar canal.

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