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Classification of Impacted Third Molars on Cone-beam Computed Tomography Images

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ABSTRACT

Background: An important anatomical factor in injuries to the inferior alveolar nerve is the spatial relationship between the mandibular canal and the corresponding third molars. This study was designed to classify the anatomic three-dimensional relationship between mandibular third molars and the mandibular canal on cone-beam computed tomography mages.

Methods: A cross-sectional study was conducted by using CBCT images of 100 individuals visiting the Dental Outpatient Department of X hospital from Jan 2022 – Oct 2022. The images were used to classify the three-dimensional relationship between the mandibular canal relative to the roots of the mandibular third molar according to Liqun Gu et al 2018 classification. In this classification, four anatomical positions were considered: buccal, lingual, apical and inter-radicular. The second factor considered was the contact and non-contact relationship between the inferior alveolar nerve canal and the mandibular nerve. The data was analyzed via SPSS version 20. Chi square test was performed to determine the contact relationship of the mandibular third molar root with the mandibular canal.

Results: Most of the mandibular canals observed via CBCT (45.0%) were located on the buccal side of the mandibular third molar followed by the apical side (26.0%), between the roots (23.0%) and very few (6.0%) on the lingual side. A significant association was found between the position of the mandibular third molar and the mandibular canal ($p<0.001$) when the position was lingual and interradicular.

Conclusions: The findings of this study revealed that the majority of mandibular third molars were located on the buccal side. There was a significant relationship between the position of the mandibular third molar and the mandibular canal.

Keywords: Cone-beam computed tomography; impaction; mandibular canal; third molar.

INTRODUCTION

The spatial relationship between mandibular canal and third molar is an important anatomic factor in inferior alveolar nerve injuries.[1] For optimal planning of the surgical approach, a radiological investigation is an initial step in determining the likelihood of postoperative injury to the IAN.[2]

OPG (Orthopantomogram) is a two-dimensional radiograph that cannot accurately determine number of roots, tooth morphology and exact location of inferior alveolar nerve.[3] Only a cross-sectional image obtained by conventional CT or cone-beam CT can define positional relationship, especially in buccolingual direction.[4] Owing to its higher spatial resolution and less radiation exposure than traditional CT, CBCT has recently become more prevalent in clinical practice.[1]

There are number of studies done on this topic globally, among which only a few are reported from our region. This study aims to classify the anatomic relationship between the mandibular third molar and the mandibular canal on CBCT images utilizing the anatomical classification.

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METHODS

This cross-sectional observational study was conducted from Jan 2022 – Oct 2022 using CBCT images of 100 patients visiting the Dental Outpatient Department of X Hospital for extraction of third molars (both sides=100 x 2). The present radiographic study was approved by the Institutional Review Committee of the Institute of Medicine [Reference no. 49(6-11) E2 078/79]. Informed consent was obtained from all individual participants before data collection.

Individuals who needed extraction of third molars and who required CBCT were enrolled in the study. CBCT images that were optimal for diagnosis were included. Individuals who had one or two mandibular third molars with fully formed roots were consecutively included in this study, with no restriction of gender.

Sample size was calculated based on prevalence of third molar impaction of right side from study done by Singh et al.[5] and using formula, $n= Z^2pq/e^2$, where n=sample size, Z=1.96, p=prevalence of third molar impaction=49.6%, e=permissible error=5%, n=384.14.

However, only 10 patients requiring CBCT for impacted mandibular molar visit the dental OPD of this hospital per month. Therefore, final sample size was derived from sample size calculation formula for finite population, Final sample size = n / [1+{(n-1)/N}, where, n = calculated sample size = 384.14, N= 10X12=120. Placing these values in the formula provided above, final sample size = 91.68. Adding 10% of non-response rate, total of 100 CBCT images were considered in this study.

The CBCT images were processed via Carestream Dental CBCT imaging system (CS 9600) to create axial, coronal, and sagittal reformation. The images were subsequently analyzed by a maxillofacial radiologist to classify the three-dimensional relationship between the mandibular third molar and mandibular canal. The position of the mandibular canal relative to the roots of the mandibular third molar and the contact relationships of the mandibular third molar and the mandibular canal in each class are classified as follows:[6] (Table 1, Figure 1)

Table 1. Position of mandibular canal relative to the roots of the mandibular third molar.

Class	Position of mandibular canal
Class I	The mandibular canal is located on the apical side (apical position)
Class II	The mandibular canal is located on the buccal side (buccal position)
Class III	The mandibular canal is located on the lingual side (lingual position)
Class IV	The mandibular canal is located between the roots (interradicular position)
	Contact relationship
1	The mandibular third molar has no contact with the mandibular canal.
2	The mandibular third molar contacts the mandibular canal with a complete white line.
3	The mandibular third molar contacts the mandibular canal with a defective white line
4	The mandibular third molar penetrates the mandibular canal.

The data were entered into a Microsoft Excel Sheet and analyzed in SPSS version 20. The means, standard deviations, frequencies and percentages were calculated depending on the nature of the data. A chi-square test was performed to determine the contact relationship between the mandibular third molar and the mandibular canal.

RESULTS

The mean age of the study participants was 27.60 ± 10.212 years. Among 100 study participants, 46 (46%) were males and 54 (54%) were females. The anatomic position of the mandibular canal concerning the mandibular third molar is presented in Table 2. Among the 200 mandibular third molar teeth observed via CBCT, 90 (45.0%) of the mandibular canals were located on the buccal side of the mandibular third molar, followed by the apical side (52, 26.00%), in between the roots (46, 23.0%) and the lingual side (12, 6.0%).

The contact relationship between the position of the mandibular third molar and the mandibular canal were found to be significantly associated with each other ($p<0.001$, Table 3). All the third molars with the mandibular canal located on the apical side had no contact (52, 100%), whereas all the mandibular canals located on the lingual side had some contact (12, 100%).

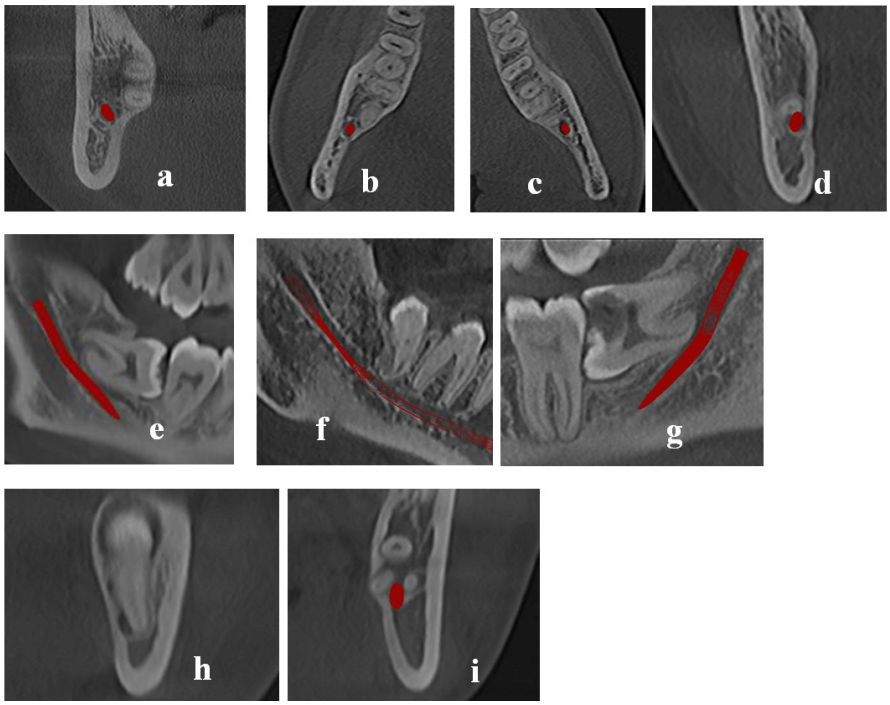

Figure 1. Classification of the position and contact relationship of the mandibular canal in relation to the mandibular third molar. a. Buccal position with no contact relation. b. Buccal position with true contact relation and a complete white line. c. Buccal position with true contact relation and defective white line. d. Apical position with true contact. e. Apical position with true contact and a defective white line. f. Apical position with true contact and a complete white line. g. Apical position with true contact and diminished caliber of the canal. h. Lingual position with true contact. i. The mandibular canal is located between the roots.

Table 2. Anatomic position of the mandibular canal in relation to the mandibular third molar. (n=200)

Classification	No contact n (%)	Contact n (%)			Total n (%)
		Contact with a complete white line	Contact with a defective white line	Penetration of the mandibular canal	
Class I: the mandibular canal locates on the apical side	52 (26.0)	-	-	-	52 (26.0)
Class II: the mandibular canal locates on the buccal side	10 (5.0)	35 (17.0)	28 (14.0)	17 (8.5)	90 (45.0)
Class III: the mandibular canal locates on the lingual side	-	-	-	12 (6.0)	12 (6.0)
Class IV: the mandibular canal locates between the roots	4 (2.0)	6 (3.0)	27 (13.5)	9 (4.5)	46 (23.0)

Table 3. Contact relationship of the mandibular third molar with the mandibular canal. (n=200)

Classification	No contact n (%)	Contact n (%)	P value*
Class I: the mandibular canal locates on the apical side	52 (100)	-	<0.001
Class II: the mandibular canal locates on the buccal side	10 (11.1)	80 (88.9)	
Class III: the mandibular canal locates on the lingual side	-	12 (100)	
Class IV: Class II: the mandibular canal locates between the roots	4 (8.7)	42 (91.3)	

*Fisher's exact test

DISCUSSION

There is a considerable risk of IAN injury when third molars are surgically extracted, especially if they are deeply seated.[7] An important anatomical element in IAN injury is the position of the third molars and Inferior alveolar nerve canal (IANC) in relation to one another. Considering this anatomical link, a complete radiographic evaluation is crucial for determining the best surgical course of action.[4]

Panoramic radiography (OPG) is routinely performed in clinical practice before mandibular third molar extraction to evaluate the risk of IAN injury.[8] Some radiographic features indicate that there is an increased risk of nerve damage associated with the removal of the corresponding mandibular third molar.[9] However, evaluating the relationship between the mandibular third molar and the IANC in the buccolingual direction is not accurate. To validate the actual presence and, eventually, the nature of the relationship in the buccal/lingual dimension, a CT or CBCT scan must be carried out whenever practical.[9] CT and CBCT can produce images in any direction and orientation. However, coronal sections are thought to be the most helpful because these projections add additional information that would not be noticeable on the OPG, such as the number of roots and the root morphology.[10]

Various radiological classifications have been proposed to identify the different types of possible relationships between the third molar and the mandibular canal.[6,11,12] The most commonly used classification systems are based on OPG findings, and they quantify the complexity of the extraction process. We chose anatomical classification since it is straightforward to understand.[6] In this classification, four anatomical positions were considered: buccal, lingual, apical, and inter radicular. In this study, 45% of the canals were situated buccal to the molars. The cross-sectional reconstructions of CBCT scans provide this fundamental information for precise planning of extraction. Subsequent coronal sections provide the apical relationship.[1]

The second factor considered was the contact and non-contact relationship. Coronal CBCT sections were helpful in determining the presence or absence of a direct link by displaying the contact and noncontact relationships. The integrity of the canal was exposed even more clearly once the images were optimized.[4] The diameter of the canal and its corticalization were carefully assessed in a contact relationship.

Liqun et al. (2018) hypothesized that the lingually positioned mandibular canal is more likely to contact the mandibular third molars because of insufficient space.[6] Our study identified 12 instances where the canal was lingual to the roots and 46 instances where the canals were placed between roots. Direct contact was observed in 42 out of the 46 canals that were located between roots. For the lingual ones, there was direct contact in every instance. This fact has somehow justified their hypothesis. Ghemeinia et al. (2009) reported that the IAN was more frequently exposed when the mandibular canal was located on the lingual side or interradicular to the third molar roots than when it was located buccally (p=0.02). Furthermore, they discovered that the mandibular canal was lingual to the third molar root in all patients with sensory impairments (p=0.02). This could be because the surgeon begins his surgical approach on the vestibular side, prompting undesirable lingually directed forces to be generated.[13] This context justified the decision to divide classes according to the IAN course (buccal/apical or lingual). However, this evidence has not yet been factored when planning the removal of third molars. It would be logical to assume that the IAN position lingual to the third molar roots must warn the surgeon to avoid lingually directed forces and apply a gentle coronally directed force in such cases. However, this hypothesis needs corroboration with clinical results.

The third aspect considered in this study was the presence/absence of corticalization of the IANC . Among the 200 scans considered, 56.5% of the molars showed loss of corticalization of the canal. The loss of cortical integrity and the size of cortical defects are associated with an increased risk of IAN injury.[14] Susarla et al. (2010) estimated that cortical interruption was associated with increased odds of IANC exposure (odds ratio of 12.8).[15] When a real relationship with the IAN occurs, paresthesia can reach an incidence of 35.6%.[16] This factor was considered, and the group of third molars that presented direct contact was further divided into two groups. Teeth in contact with the IANC with preserved caliber and corticalization as opposed to teeth in contact with the IAN and with the lost caliber and corticalization.

Teeth with direct contact and penetration into the canal can cause laceration of the vasa vasorum or compression of nerves due to the force applied during extraction or to postsurgical edema, which can elicit neuropraxia. Among all the participants in this study, 38 canals revealed direct contact with the root apex penetrating into the canal, which suggests that there

is a significant likelihood of nerve damage. To prevent nerve damage, the extraction of all these teeth was postponed and coronectomy was performed. The crown was entirely separated during coronectomy; however, the roots were kept in the alveolar fossa. The pulp was unaffected, and the residual roots were at least 3 mm below the crest of the alveolar bone.[17] Owing to increased bone growth above the roots, root remnants have the capacity to move away from the mandibular canal after surgery. This decreased the likelihood that an additional operation was required to repair the IAN lesion.[18] Several randomized control trials have shown that CBCT does not lead to a reduction in nerve injury.[19-22] However, these studies used CBCT to visualize the three-dimensional relationship of the third molar root with the IAN and evaluate the risk involved, but did not change the surgical plan, which is the primary reason that CBCT should be ordered first. The answer to the question of how much IAN injury can be reduced or avoided if CBCT is used to appraise the risk can be ascertained only by a trial of such high-risk cases in two treatment arms: one in which a conventional surgical plan is carried out, whereas in the other, only coronectomy is carried out and roots are left undisturbed; any difference in temporary or permanent IAN injury is compared. However, such a clinical trial will not be ethical and not justified. Thus, we need to rely on evidence from intentional coronectomy results, which indicate that in high-risk cases, intentional coronectomy is associated with almost no cases of nerve injury. Therefore, CBCT can be considered superior in predicting the risk of IAN injury and reducing the risk of IAN injury, if the treatment plan is tailored on the basis of the apparent risk level.

This study has some limitations. This is a single center study with a small sample drawn through a convenience sampling technique that might not adequately represent the diversity of impacted third molars seen in a larger population. Also, among different classification techniques available in literature, this study uses only one classification based on position of mandibular canal and its contact relationship.

CONCLUSIONS

The study findings revealed that the majority of mandibular third molars were located on the buccal side. There was a significant relationship between the position of the mandibular third molar and the mandibular canal. The present study revealed that CBCT helps visualize the relationship between the third molar root and IAN risk. Therefore, risk appraisal of IAN injury via CBCT should be followed by an appropriately tailored treatment plan to reduce IAN injury. CBCT can be considered superior in predicting and reducing IAN injury risk if the treatment plan is based on the apparent risk level. Not a good recommendation

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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