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Use of CBCT scan for introducing a radiological classification of impacted third molar

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Abstract

Background: The impaction rate is much higher for third molars as compared to other teeth. While impacted third molars may remain asymptomatic for an indefinite period, it can cause various delinquents, such as pericoronitis, swelling with pain, distal caries, bone loss, root resorption of adjacent teeth, odontogenic cysts, and tumors. That's why the most frequent surgical procedure in dentistry is third molar tooth extraction.
Objective: The aim is to propose a new classification for impacted mandibular third molars on CBCT images which cover all aspects of the anatomical situation
Methodology: A total of 143 images of molar teeth was collected and classified according to a relationship with the IAN canal and molar tooth. For statistical calculation, SPSS software was used.
Results: Classes 0-7 were planned and in which classes 1-6 were sectioned into two subtypes (subtypes A-B). The distribution of the classes presented an occurrence of buccal or apical course of the mandibular canal tailed by lingual position and inter-radicular one. Results emphasized that a close relationship of molar roots with the lingual side of IAN was more in female versus male other than it no anatomic differences occur in terms of IAN relationships between males and females. Younger patients displayed an increased rate of direct contact with a reduced calibre of the canal and/or without corticalization. This increases the chances of IAN damage, especially in the young woman (age range 25-30 years) with a lingual course of the mandibular canal.
Conclusion: The use of this classification is appreciated to get an equal definition of the impacted tooth on CBCT images worldwide.

Keywords: Third molar, CBCT, classification, IAN.

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Introduction

The third molar tooth is situated at the end of the lower or upper jaw. It breaks out at the age of 17-23 years. It is also named as a wisdom tooth [1] Impaction of a tooth is an uncontrolled situation where a tooth fails to attain its regular serviceable position. The reason behind this tooth impaction in the jaw is malposition, physical barrios, small space, or other impairments [2]. The impaction rate is much higher for third molars as compared to other teeth. While impacted third molars may remain asymptomatic for an indefinite period, it can cause various delinquents, such as pericoronitis, swelling with pain, distal caries, bone loss, root resorption of adjacent teeth, odontogenic cysts and tumors. That's why the most frequent surgical procedure in dentistry is third molar tooth extraction [3].

Conversely, complications after surgery are more severe, and the signs and disorders do not resolve without additional management. If excessive force is applied during wisdom tooth extraction it may lead to prolonged temporomandibular joint disorder after surgery, because of disc dislocation or traumatic soreness around the joint complex. Additionally, loss of blood clots during extraction can cause alveolar Osteitis (Dry socket) which is a delayed healing, inflammatory complication. The bad odor from the mouth, dull throbbing pain, and/ or mentioned the pain to the ear or adjacent teeth without any infection are the most common symptoms related to dry socket disorder. These issues increased the cost of treatment and hospital visits [4].

The third molar tooth extraction source to the injury of the inferior alveolar nerve (IAN) is increased with the closeness of the mandibular canal (MC) to the root of the third molar [5, 6] .It can be reduced by proper planning and evaluation of the risk of IAN. To get a clear picture of soft tissues and IAN dentists use radiography methods [7, 8].

Nerves are involved with the third molar teeth, which makes the extraction process complicated. To overcome this problem radiology is introduced in dentistry. The conventional CT or cone-beam CT (CBCT) can express the mandibular canal's relationships with the molar teeth in a term of buccal/ lingual direction [9]. But the higher cost and higher dose of medicine is the main disadvantage associated with this treatment [10]. Recent advancements in the technology of, CBCT avail 3D pictures of teeth with less amount of radiation dose as compared to conventional CT, which makes it more popular among the other methods [11, 12]. This technique is used in implants insertion, orthodontics, endodontics and oral and maxillofacial surgery [13, 14].

Materials and Methods

Subject: A total of 200 patients were selected for study purposes whose third molar extraction surgery was done under the supervision of the senior doctor. A duly filled consent form was collected with each and every patient for filling.

Exclusive area: Pregnant or Patients with the inability to maintain standing or sitting position were excluded from the study.

Inclusive area: Patients which have a close relationship with the mandibular canal on orthopanto-mography (OPG) were included in this study. This study had not any restriction of

age or gender. CBCT examination was performed, whenever a physical contact between the mandibular canal and third molar roots was alleged, in presence of Rood's signs.

Data collection and examination: Second CBCT examination was conducted on 100 patients, 30 males, and 70 females with an age range of 16-80 years and a mean age of 34and 31 years. An oral and maxillofacial surgeon (M.M.), with an oral surgeon (F.C.) and a clinical radiologist with experience in the field of oral and maxillofacial radiology (G.B.), examined the CBCT images of the patients. A CBCT scanner (NewTom VGi, Verona, Italia) was used to take images and technical parameters were: 110 kV, 0.3-2 mA, range mAs 2.5- 6.7, scan time <12s, FOV of 12x8cm or 12x15 cm. The slice thickness of axial images was 0.25 mm and Voxel size was 0.25 mm. The delivered dose was 2.0-2.2 mGy ± 30%. DICOM format was used for images and evaluated by axial, cross-sectional, and sagittal reconstructions with a thickness of 1 mm and a cutting interval of 1 mm. Dental software was used to handle images and to create panoramic and sagittal oblique (cross-sectional) reformatted images of the maxilla and mandible.
Classification selected for study purpose was easy to use, has a scientific approach, broadly used in hospitals, comprehensive and relatable.

Statistical analysis: The SPSS software was used for statistical scrutiny. The following tests were performed for various calculations:

- Cohen K values-for inter-observer agreement.
- Fisher's test-to evaluate the difference in the frequency of the classification classes and subtypes between male and female groups and to find differences in the distribution of cases with contact between IAN and roots while it was buccal/apical, lingual or inter-radicular.
- Univariate ANOVA-to calculate the difference in age distribution between classes.
- Post-hoc Bonferroni test-for the pairwise comparisons.

Results

The final classification used for the study (describing the possible IAN/third molar relationships in the buccal/lingual direction) was demarcated as follows:

1. **Class 0:** Plexiform canal, when the mandibular canal is not visible.
2. **Class 1:** The cortical limitations of the canal are not interrupted. The mandibular canal goes apically or buccally with respect to the tooth but without any touching.

- Subtype 1A: the distance IAN/tooth >2 mm
- subtype 1B: the distance IAN/tooth < 2 mm

3. **Class 2:** The cortical limitations of the canal are not interrupted because the mandibular canal turns lingually to the tooth without any touching.

- **Subtype 2A:** The distance IAN/tooth >2 mm.
- **Subtype 2B:** The distance IAN/tooth < 2 mm.

4. **Class 3:** The tooth is touched with the mandibular canal apical or buccal.

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- **Subtype 3A:** The mandibular canal displays a conserved diameter in the point of interaction.
- **Subtype 3B:** The mandibular canal displays a smaller calibre and/or adisruption of the corticalization in the point of interaction;

5. **Class 4:** The tooth is touched lingually by the mandibular canal.

- **Subtype 4A:** The mandibular canal displays a conserved diameter in the point of interaction.
- **Subtype 4B:** The mandibular canal displays a smaller calibre and/or a disruption of the corticalization in the point of interaction;

6. **Class 5:** The mandibular canal goesin the middle of the roots but without touching them.

- **Subtype 5A:** The distance IAN/tooth >2 mm.
- **Subtype 5B:** The distance IAN/tooth<2 mm.

7. **Class 6:** The mandibular canal goes in the middle of the roots by touching them.

- **Subtype 6A:** The mandibular canal displays a conserved diameter in the point of interaction.
- **Subtype 6B:** The mandibular canal displays a smaller calibre and/or a disruption of the corticalization in the point of interaction.

8. **Class 7:** The mandibular canal stuck between the attached roots.

The inter-observer agreement ranged from good to excellent (K value range: 0.67-0.88) for the valuation of classes and subtypes on CBCT images.

The dissemination of classes and subtypes in the study group is demonstrated in table 1. The most signified classes were 3A (20%), 3B (23.88%), and 4B (20%). According to gender-wise evaluation, more numbers were found in class 3B for males (43.13%) and 4B for females (47.01%). No significant variances were detected in the distribution of classes in both gender study groups, other than class 4B (Fisher exact test; $p< 0.05$) as shown in table 2.

The predominance of buccal/apical, lingual, and inter-radicular course of the mandibular canal was also coordinated with the existence or non-attendance of direct contact with roots. The most recurrent anatomical course was buccal or apical when IAN, was not in contact with the third molar teeth. For the lingual course, only one case was exposed and for the inter-radicular zero cases were found. In the reference of direct contact between IAN and the tooth mainly buccal or apical course was found, on the other hand, a noteworthy higher amount of cases of lingual course were observed as compared to the "no contact" group (Fisher exact test; $p< 0.001$) as shown in Table 3.

Table 1: Frequency of Classes and Subtypes of the CBCT Radiological Classification in the study group

CBCT Radiological Classification	Frequency (n, %) in the study population (n= 143)	Frequency (n, %) in males group (n= 60)	Frequency (n, %) in females group (n= 83)	Age (mean ± SD)*
0	0%	0%	0%	_
1A	14.60%	24.50%	23.60%	43±3
1B	16%	32.76%	21.01%	23.8±1.75[b]
2A	0%	0%	0%	_
2B	0.81%	4%	0%	32

3A	20%	38.98%	28%	33.5±2.89
3B	23.88%	43.13%	38.01%	31.17±3
4A	0.81%	0%	2.51%	27
4B	20%	19%	47.01%[a]	33.9±3
5A	0%	0%	0%	_
5B	0%	0%	0%	_
6A	0.81%	0%	2.51%	18
6B	3.95%	7%	4%	21±0.5[b]
7	0%	0%	0%	_

A Significant difference in respect with males group (Fisher exact test, $p < 0.05$).
B Significant difference in respect with 1A (post-hoc Bonferroni test, $p < 0.001$).
* Univariate ANOVA, $p < 0.00$.

Table 2: The course of the mandibular canal in respect to the impacted third molar. The presence or absence of a direct relationship is shown

Position	No contact IAN/third molar	Contact IAN/third molar	Total
Buccal or apical	45	62	107
Lingual	0	30[a]	30
Inter-radicular	1	5	6
Total	46	97[b]	143

[a]significant difference in respect with "No contact" group (Fisher exact test , p<0.005)
[b]significant difference in respect with "No contact" group (Fisher exact test , p<0.005)

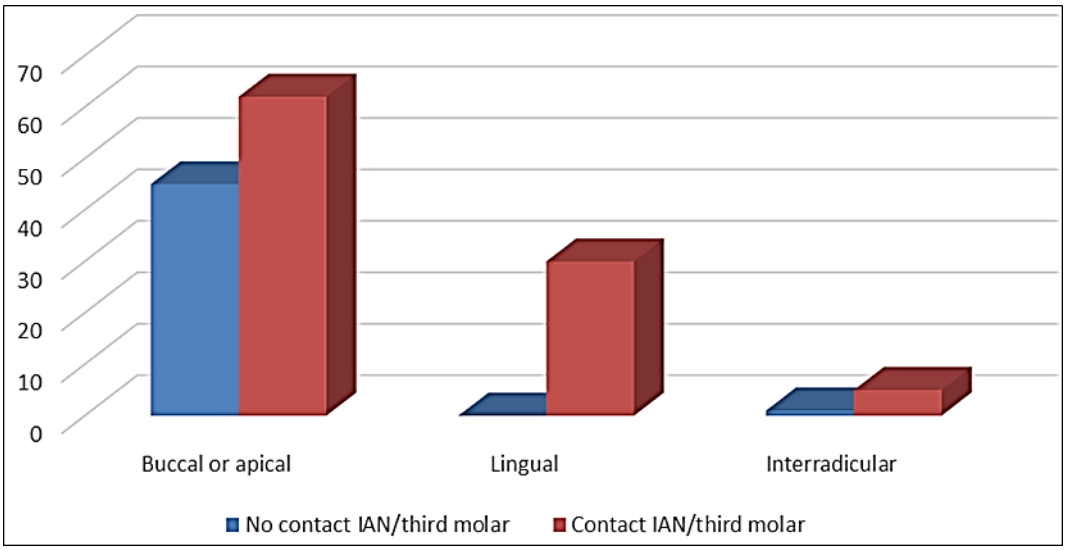

Chart 1: The presence or absence of a direct relationship of IAN with third molar

Discussion

The best possible route of removal of the impacted teeth can be figured out by methodical and scrupulous classification of the position of impacted molar teeth. For the minimization of post-operative risks and treatment management, many classifications were given in history. The first classification was introduced in 1926 by winter, it is built on the leaning of the impacted third molar to the long axis of the second molar [15]. In 1933, Pell and Gregory introduced another classification, which is based on the position of the inferior third molar with respect to the mandibular bone and second molar occlusal plane. These two are the most popular classification among others or are still in use [16].

Our study classification is focusing to give the exact relationship between the roots of the mandibular third molar and the IAN and tries to cover all anatomical situations. CT or CBCT

was used to get spatial images of the impacted tooth for further categorization of classes and subclasses.

The damage of nerves is increased with the minimization of the distance of the mandibular canal and impacted teeth. This statement was advocated by Jhamb *et al*. [17] who divided the measured distance with cortical break into 4 categories, (> 1 mm, 0 to 1 mm, 0 mm and 0 mm) and Sammartino *et al*. [18] She projected a safety distance from IAN of 1.5 mm to avoid indirect cuts of the nerve bundle during implant placement. That's why we choose a cut-off of 2 mm in our classification to separate cases with higher risk or lower risk.

Our purposed classification subdivide classes either by buccal/apical or lingual, this is justified by findings of Ghaeminia *et al*. She observed that the IAN was more often exposed when the mandibular canal was located at the lingual or inter-radicular side to the third molar roots than buccally ($p < 0.02$) and caused more sensory impairments. It could happen because the surgeon starts his surgery from the vestibular side, and create force lingually which is harmful. [19].

The risk of IAN injury was increased with the loss of cortical integrity and the size of cortical defect was estimated by Susarla *et al*. [20]. That aspect is also considered in our classification for auxiliary differentiation (as preserved calibre and corticalization).

The age group distribution in our study is not equal but the difference was statistically significant for 1B and 6B classes in respect to class 1A (post-hoc Bonferroni test, $p < 0.001$). Which elucidates the maximum number of impactions seen was 25-30 years which was also the mean age group in the studies done by De Melo [9] *et al*. 4B subdivision shows a close relationship of molar roots with lingual side of IAN was more in female versus male. It is associated with the buccal/lingual thickness of the mandibular bone, estimated by Nakagawa et al. Females has thin mandibular bone as compared to male so reflect a close relationship. (21)

In our study classification, the distribution of the classes presented an occurrence of buccal or apical course of the mandibular canal tailed by lingual position and inter-radicular one. These results are in agreement with previous literature [9, 22]. When data were matched with the presence or absence of interaction between IAN and third molar, regardless of corticalization of the canal or not, a significant difference was observed for the lingual course and inter-radicular course. These outcomes are correlated by Jhamb *et al*. [17].

Conclusion

The study was done with the aim to propose a new classification for impacted mandibular third molars on CBCT images which cover all aspects of the anatomical situation. The study group of an initial sample of 143 impacted third molars was taken. Results emphasized that a close relationship of molar roots with the lingual side of IAN was more in female versus male other than it no anatomic differences occur in terms of IAN relationships between males and females. Younger patients displayed an increased rate of direct contact with a reduced calibre of the canal and/or without corticalization. This increases the chances of IAN damage, especially in the young woman (age range 25-30 years) with a lingual course of the mandibular canal.

Further studies will be required because some classes had not reported any cases due to a rare anatomical situation. However, the use of this classification is appreciated to get the equal definition of impacted teeth on CBCT images worldwide.

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