

PREVALENCE OF DISTAL SURFACE CARIES IN MANDIBULAR SECOND MOLAR ADJACENT TO IMPACTED THIRD MOLAR IN A SAMPLE OF ISMAILIA POPULATION: A CONE BEAM COMPUTED TOMOGRAPHY STUDY

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DOI: 10.21608/dsu.2025.317324.1256 Manuscript ID: DSU-2409-1256

KEYWORDS

CBCT, Distal surface caries, Impacted third molars, Prevalence.

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ABSTRACT

Introduction: Worldwide research has shown that mandibular third molars are the most often impacted teeth in the jaw, followed by maxillary canines then mandibular premolars. Impacted third molars may be associated with several pathologies related to impacted tooth itself or adjacent second molar such as periodontal problems, root resorption and distal caries of adjacent teeth. Aim: The purpose of the present study was to determine the prevalence of distal surface caries in mandibular second molars adjacent to impacted third molars in a sample of Ismailia population using CBCT. Methods and Methods: The present study was conducted on 196 unidentified CBCT scans selected from the archives of the Oral and Maxillofacial Radiology Department, Suez Canal University. Demographic data regarding (gender), side of impaction distribution and impaction angulation was assessed. Angulation of impacted third molar was evaluated using Winter's classification, then radiographic assessment for each scan was carried out using On-Demand software to determine the presence and prevalence of coronal and radicular caries on the distal surface of the second molar adjacent to impacted mandibular third molars. Additionally, correlation of the associated risk factors for caries occurrence was carried out. Results: The results of the current study revealed that mesio-angular impaction was the most frequent type of impacted third molar (63.8%) followed by horizontal impaction (17.3%). The prevalence of DSC for both coronal and radicular distal caries, was 8.7% with relatively higher female predilection and higher occurrence in association with mesio-angular and horizontal types of impactions. Conclusion: Cone Beam Computed Tomography being a threedimensional imaging modality, is considered an accurate and precise radiographic modality that can be reliably used for early detection of distal surface caries. Moreover, the presence of DSC in mandibular second molar adjacent to impacted third molars among Ismailia population is relatively low and is more related to mesio-angular and horizontal type of impaction.

INTRODUCTION

Impacted teeth are characterized as those that are either entirely or partially embedded in the jawbone or mucosa after their typical eruption period, once their roots are fully developed.⁽¹⁾ According to published research, the worldwide prevalence of impacted teeth ranges from 6.9% to 76.6%. As the last teeth to erupt in the oral cavity (18-20 years), third molars are the most often impacted teeth, particularly mandibular

third molars, followed by maxillary third molars, maxillary canines, mandibular premolars, and lastly, maxillary incisors ⁽²⁻⁴⁾.

The impaction of third molars is a topic of debate due to the numerous factors that contribute to this process. The various patterns of impaction are influenced by facial growth, jaw size, tooth size, racial features, and inheritance factors ⁽⁵⁾. The occurrence of tooth impaction has been the subject of numerous hypotheses, such as the early exfoliation of deciduous teeth, reduced space for the erupting tooth, or a smaller arch size ⁽⁶⁾.

An impacted third molar might predispose neighboring second molars to adverse consequences, including distal surface caries (DSC), external root resorption (ERR), and periodontal problems^(4,7,8). Unfortunately, this may lead to the development of pulpitis or apical periodontitis in second molars with pain and discomfort to the patient, and perhaps necessitating endodontic treatment or extraction of the second molar adjacent to the impaction, with its subsequent health and functional complications^(9,10). Therefore, early diagnosis of such pathological conditions and prompt management will improve treatment, prognosis and prevent the associated complications⁽¹¹⁾.

Accordingly, the study of prevalence and pathological conditions associated with impactions has been the focus of several studies, whether these pathologies were related to the impacted tooth itself as pericoronitis, caries, odontogenic cysts and tumors or in the adjacent second molar as distal surface caries, ERR and bone loss .Hence ,the aim of the present study was to determine the prevalence of distal surface caries in mandibular second molars adjacent to impacted third molars in a sample of Ismailia population using CBCT and associate the possible risk factors that may predispose to its occurrence.

MATERIALS AND METHODS

I. Study settings and design

The current retrospective cross-sectional study was performed on the CBCT scans of 196 mandibular second molars adjacent impacted mandibular third molars. The CBCT images were collected from the data base of the department of Oral and Maxillofacial Radiology, Faculty of Dentistry, Suez Canal University. The study was given the approval number 510/2022 by the Research Ethics Committee of the faculty of Dentistry.

The number of scans was set according to the sample size calculation using the computer program SPSS software for windows version 26.0 in agreement with **Gupta et al.**⁽¹²⁾ who have published their study using the same number of scans.

The CBCT scans were chosen to fulfill the following **inclusion criteria**:

- 1. Scans of Egyptian habitants of Ismailia government.
- 2. Scans of patients older than 18 years old (adult patients).
- 3. Both genders were included in the present study.
- 4. CBCT scans showing unilateral or bilateral mandibular impacted (partially or completely) third molars and the adjacent second molars.
- 5. Roots of mandibular third molars were completely formed.
- 6. High quality radiographs with no artifacts obscuring the required area of examination.

a. Imaging procedure

The radiographic examination for all scans of patients included in the present study was performed

at the Oral and Maxillofacial Radiology department, Faculty of Dentistry, Suez Canal University using SCANORA 3Dx CBCT (Scanora 3DX, Soredex, Finland) scanner and The FOV and the exposure parameters were fixed for all scans as follows; FOV 80*165 mm, 0.35 voxel size, 90kV, 10mA and exposure time 2.4seconds.

b. Image Assessment

- OnDemand software (CyberMed Inc.Seoul, Korea) was used to perform the image analysis procedures.
- The acquired image data was transferred into DICOM format to be imported from SCANORA to OnDemand 3D software application for further image evaluation and analysis.
- The image display in OnDemand software shows the basic 3 orthogonal planes and the 3D image. Image enhancement tools (brightness, contrast, and magnification) were freely used by the observers to improve image visibility.
- The criteria of presence of different pathologies were set and agreed upon by the two radiologists with four- and fifteen-years' experience in the field of oral and maxillofacial radiology assessing the scans before the beginning of the radiographic evaluation. Each radiologist assessed the radiographs twice with two weeks' time interval between examinations for evaluation of intra-observer and inter-observer reliability.

II. Assessment of Radiographic Outcome

A. <u>Classification of impacted mandibular third</u> <u>molar (Winter's Classification)</u>

The classification of the type of impaction used in the present study was performed according to Winter's classification ⁽¹³⁾; which is based on the assessment of the angle between the long axis of the impacted third molar and the long axis of the adjacent second molar as presented in **Figure (1)**.

The angulation was determined from the sagittal cut of the CBCT scans as the angle formed between the intersected long axis of second and third molars, as described by a pervious study by **Elkassas** *et al.*⁽¹⁴⁾. The long axis of each molar was drawn by the software ruler as a line vertically crossing through the center of the occlusal surface and the mid furcation area. ⁽¹⁵⁾ Then, the type of impaction was accordingly determined based on the angle obtained as follows:

- a) Vertical impaction (-10° to 10°):
- b) Mesioangular impaction (11° to 79°):
- c) Horizontal impaction (80° to 100°):
- d) Distoangular impaction (-11° to -79°):
- e) Buccolingual impaction: the tooth can be buccally impacted (tilted toward the cheek) or/and lingually impacted (tilted towards the tongue).
- f) Others (-111° to -80°): The definition 'other' includes; disto-horizontal, mesio-invert, distoinvert teeth).



Fig. (1) Winter's classification (13)

B. <u>Detection of mandibular second molar Distal</u> Surface Caries (DSC)

- Starting from the sagittal view, scrolling from buccal to lingual surfaces was carried out carefully examining the integrity of the distal surface of the crown and the root of the 2nd molar. Additionally, in the axial view, the integrity of the distal surface of the crown and the root of the 2nd molar was assessed superior-inferiorly.
- Distal caries in the 2nd molars was considered present when a radiolucency was seen in enamel and/or dentine (above the CEJ) the so-called "distal coronal caries" or involving dentin and cementum (below the CEJ) known to be" distal root/radicular caries" in any of the sagittal or axial planes⁽¹⁶⁾.
- The radiolucency was considered caries when irregular margins were observed in the enamel and/or dentine in either the sagittal or axial cuts above CEJ or involving cementum and dentin below the CEJ, and a clear gap existed between

the crown of the mandibular third molar and the distal aspect of mandibular second molar ⁽¹⁷⁾ as shown in **Figure (2)**. Distal carious lesions were accordingly classified into coronal or radicular surface caries, based on its location.

III. Statistical Analysis

All data were collected, calculated, tabulated and statistically analyzed. A normality test (Shapiro-Wilk) was done to check normal distribution of the samples. The Chi-square test was used to test significance of association between categorical variables and Chi-square test of independence was used to determine the association between distal caries with gender, side of impaction and type of impaction, Kappa test was done to determine intra and inter-observer reliability. All statistical analysis was done using the computer program SPSS software for windows version 26.0 (Statistical Package for Social Science, Armonk, NY: IBM Corp) at significant levels 0.05 (P- Value ≤0.05).



Fig. (2) Sagittal cut(left) and axial cut (right) showing distal coronal caries involving the distal aspect of the adjacent second molar to the mesio-angular impacted third molar displayed as a radiolucency with irregular margins and morphology.

RESULTS

I. Reliability analysis

The values of kappa test regarding all radiographic findings ranged from (0.954 to 0.998) denoting very good intra observer and inter observer agreement.

II. Descriptive data:

A. Gender distribution:

Based on gender, about 41.8% of 107 patients were males and 58.2% were females. With a statistically significant higher females' predominance.

B. Side of impaction:

The majority of impacted third molars (52.6%) were on the left side, while 47.4% were on the right side. There was no statistically significant difference between number of scans in the right and left sides.

C. Distribution of the type of impaction in the study sample based on Winter's classification:

Based on Winter's classification, the most frequent type of impacted third molar in the study sample was mesioangular at (63.8%), followed by horizontal (17.3%), then vertical (16.8%), while the buccal and lingual showed frequency of (1.5%) and finally the distoangular with the lowest frequency (0.5% only one case). Statistical analysis using chi square test at P<0.05 showed significant difference between different impaction types as shown in figure (3).



Fig. (3) Pie chart showing distribution of different types of impactions in the study sample using Winter's classification (angulation of impaction).

III. Assessment of Distal Surface Caries in Mandibular Second Molar:

A. Distal Coronal caries

a. Prevalence of Distal Coronal caries in Mandibular Second Molar:

Regarding prevalence of coronal caries, about 92.3% of the examined scans showed no distal coronal caries, while only 7.7% showed coronal caries. There was a high statistically significant difference between absence and presence of Distal Coronal caries as shown in table (1).

Table (1) Prevalence of coronal and radicular DSC

Coronal DSC			Radicular DSC	
	Ν	%	Ν	%
Absent	185	92.3	194	99
Present	11	7.7	2	1
Total	196	100	196	100
Chi-square	140.59		188.08	
P- value	<0.0001**		<0.0001**	

**; means significant difference at P<0.05 ns; means no significant difference at P>0.05

b. Prevalence and Association of coronal distal caries with gender, side of impaction and angulation of impaction:

Statistical analysis showed non-significant association between the prevalence of coronal distal caries and gender where females showed 54.5% and males 45.5% (p=0.763) fig.(4)

Regarding side of impaction, there was also a non-significant association between the impaction side and prevalence of coronal distal caries, where the left side showed 27.3% while the right side showed 72.7% (p=0.13) fig. (4)

Similarly, there was non-significant association between the angulation of impaction and prevalence of coronal distal caries, where coronal distal caries was present only in cases of impacted wisdom with mesioangular and horizontal impactions at 63.6% and 36.4% respectively. Since p value=0.36, therefore, there was no significant association between the types of impaction and the prevalence of coronal distal caries as seen in **fig.(4)**.



Fig. (4) Prevalence and association of coronal caries with gender, side of impaction and type of impaction.

B. Distal Root caries in Mandibular Second Molar:

a. Prevalence of Distal Root caries in Mandibular Second Molar:

Regarding **Root caries prevalence**, 99.0% of the examined scans showed absence of distal root caries while only 1.0% showed presence. A high statistically significant difference between absence and presence of distal root caries was seen (p<0.0001) as shown in table (1).

b. Prevalence and Association of root caries with gender, side of impaction and types of impactions:

There was non-significant association between distal root caries and gender, side of impaction or the types of impactions. Regarding **gender**, the males were 100% and there was no female patient reported with root caries fig. (5), while regarding

the **side** of impaction, results showed 50% in the right side and 50% in the left side with no significant association between both sides(p=1).

Regarding the **type** of impaction, horizontal impaction showed 100 % of root caries cases, while no root caries was recorded in the mesio-angular, distoangular, vertical, buccal or lingual impactions, therefore there was no significant association between the types of impaction and root caries as presented in fig (5).



Fig. (5) Prevalence and association of root caries with gender, side of impaction and type of impaction

DISCUSSION

One of the most frequently impacted teeth in the oral cavity is the mandibular third molar, with an estimated worldwide prevalence of 16-73%. This impaction induces multiple pathologies and various signs and symptoms within the impacted molars that may lead to their ultimate removal, which is considered as one of the most frequently performed surgeries in the maxillofacial region ⁽¹⁸⁾. Moreover, due to such impaction, many pathological entities can be induced in the adjacent second molars one of which is dental caries. The initiation and progression of dental caries in intact adjacent teeth might ultimately lead to their loss. Therefore, the knowledge of the prevalence of distal caries through

population-based studies is an important step in the epidemiological field which may lead to saving of such teeth.⁽¹⁹⁾.

The objective of the current study was to identify the prevalence and risk factors of distal surface caries, which is one of the most prevalent pathologies affecting mandibular second molars as a result of the presence of an adjacent impacted third molar, to enrich the relatively deficient Egyptian database with outcomes that could benefit surgeons and dental practitioners in Egypt and the Ismailia government particularly, by providing evidence to augment the ongoing database regarding the decision to prophylactically extract impacted third molars. This is because the evidence-based data from well-conducted clinical trials and systematic reviews are not yet sufficient to justify the routine prophylactic extraction of impacted third molars ⁽¹⁸⁾.

The current retrospective study used CBCT images for evaluation of the pathologies related to second molar, due to the increased accuracy and absence of superimposition in 3D imaging modalities compared to 2D conventional ones⁽¹⁴⁾.Only CBCT scans free of metallic artifacts were included in the study to ensure accurate visualization of the area of interest without streak artifacts which may render diagnosis of pathologies difficult, especially since the evaluation of initial lesions of dental caries require high image quality⁽¹⁹⁾.

In the current study, CBCT scans of adult patients more than 18 years of age were chosen to guarantee the complete formation of roots of both third and second molars. Both genders were included in the study in order to determine whether there was a significant correlation between gender and the prevalence of specific pathologies related to second molars as suggested by several previous studies ^(15,19). The impaction angulation was determined using Winter's classification⁽²⁰⁾, since it is most commonly used by researchers as **Oenning** *et al.*⁽²¹⁾, **Kang** *et al.*⁽²²⁾, **Wang** *et al.*⁽²³⁾, **Li** *et al.*⁽²⁴⁾. Additionally, Winter's classification is effective not only for sharing diagnostic information before tooth extraction, but additionally, such classification is important from an educational perspective.⁽²⁵⁾

Concerning radiographic detection of distal surface caries in mandibular second molars, sagittal and axial cuts were evaluated for its presence by each observer searching for any radiolucency above CEJ in enamel or dentine to be recorded as distal coronal caries, or below CEJ in dentine or cementum recorded as distal root caries. Such method was adopted by several previous studies as those conducted by Soviero et al. (16), Kang et al. (22) and Elkassas et al. (14), who detected proximal caries using CBCT and proved its reliability. Regarding the common confusion between root surface caries and external root resorption, the lesion was diagnosed as caries as clarified by Wang et al.^(23,26), whenever the detected radiolucency had an irregular shape and a noticeable gap observed between the second molar and the dental crown of the third molar,

Regarding the results of the present study, statistical analysis revealed that **females** showed higher prevalence (58.2%) of impacted third molar than males. This disparity is most likely due to the fact that women's jaws are smaller than men's. This is because women's skeletal growth usually ends earlier than in males before the third molars erupt, whereas males' jaw continues to grow during third molar eruption creating more space for eruption⁽²⁷⁾.

The most prevalent **angulation type** of impacted mandibular third molar was the mesioangular (63.8%), followed by horizontal (17.3%), then vertical impaction (16.8%), whereas buccolingual and distoangular positions showed the lowest prevalence (0.5%).

The majority of previous prevalence studies were in agreement with such findings, where they found that in the African Americans, Americans, Singaporeans, Arabians, and Iranians respectively. mesioangular type of impaction was the most type^(6,28,29,30,31). prevalent The mesioangular impaction prevalence could be accredited to the pattern of eruption of the mandibular third molar tooth in the ramus, in which it develops with its occlusal surface facing forwards in a horizontal position and as a space becomes available due to growth of the mandible, it rotates into a more mesioangular form and then finally into an upright position⁽³¹⁾.Therefore, failure of rotation from the mesioangular to the upright direction maybe the reason why mesioangular impaction showed the highest prevalence. However, these findings were in contrast to those of Hugoson and Kugelberg⁽³⁰⁾ who found the vertical angulation to be the most common type of third molar mandibular impaction among Swedish population. This could be due to the fact that a different method of classification of angulation was used in their study.

Regarding **distal caries**, in the present research the prevalence of distal coronal caries in mandibular second molars was only 7.7% with insignificantly higher female predilection (54.5%) and no association between the side, type of impaction and the prevalence of coronal caries. While regarding the prevalence of distal root caries, only 1% of the scans of male patients showed incidence of root caries in association with horizontal impaction no association with the side or other types of impactions.

Our findings study showed that **mesioangular impaction** was the most common type of impaction associated with the presence of distal coronal caries (63.6%) followed by horizontal impaction (36.4%). These findings are consistent with those of **Ozec** *et al.* ⁽³¹⁾, **Kumar** *et al.* ⁽³²⁾ and **Prajapati** *et al.* ⁽³³⁾. According to **Chang** *et al.* ⁽³⁴⁾, food

retention increases with increasing the angulation of mandibular third molar and the subsequent increasing distance between it and the adjacent second molar; the likelihood of caries development increases since it is difficult to keep proper dental hygiene measures.

The current findings regarding occurrence of distal surface root caries and angulation of adjacent impaction were in accordance with those of a pervious study conducted by Kamal et al.⁽³⁾, who reported that, the horizontal impaction was associated with the highest incidence of distal root caries (38.9%) in comparison to the mesio-angular (17.1%), whereas in the present study, distal root caries was only related to horizontal impaction. Such variation among findings might be attributed to differences in the sample size populations among the studies. The association between second molar distal surface caries and both demographic and radiographic characteristics was carried out in the present study to help predict risk factors that need to be considered in follow up of impaction cases concerning Ismailia citizens.

CONCLUSION

Cone Beam Computed Tomography is considered an accurate and precise radiographic modality that can be reliably used for early detection of distal surface caries in second molars adjacent to impacted third molars. The presence of DSC in mandibular second molar adjacent to impacted third molars among Ismailia population is relatively low and is more related to mesio-angular and horizontal type of impaction. However, prophylactic removal of mesioangularly and horizontally located third molars among Ismailia population could be suggested to decrease future expected complications in second molar. Alternatively, regular radiographic follow up of such types of impactions is strongly advised.

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