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ASSOCIATION BETWEEN PATTERNS OF MANDIBULAR THIRD MOLAR IMPACTION AND VARIOUS COMPLICATIONS IN THE ADJACENT SECOND MOLAR USING CONE BEAM COMPUTED TOMOGRAPHY: A RETROSPECTIVE STUDY

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ABSTRACT

Background: Mandibular 3rd molars (M3) are frequently get impacted and resulted in various sequelae on mandibular 2nd molars (M2), including; caries, periodontal bone loss (PBL) and external root resorption (ERR). The aim of this study was to assess the incidence of different patterns of impacted M3 and their association with the severity of various complications affecting the adjacent M2 using 3 dimensional CBCT.

Methods: A total of 246 impacted M3 were retrospectively selected and categorized based on angulation, occlusal plane level with M2, and their relation to anterior border of ascending ramus by 2 radiologists using CBCT images. M2 were evaluated for the presence of distal caries, distal PBL and ERR. Chi-square test and one-way ANOVA test were used for data analysis.

Results: The highest occurrence of different impaction patterns was mesioangular 48%, level A 45.9%, class I 59.3%. PBL was the most common complication detected in adjacent M2 at 65%, followed by ERR 38.2%, and caries 30.9%. There was a significant association between caries severity and impaction angulation (p=0.002). PBL and ERR severities and all impaction patterns were significantly associated (p <0.001).

Conclusion: There was an association between different patterns of impacted M3 and the severity of various complications in the adjacent M2. **Clinical relevance:** Observing and assessing the level, depth, and position of lower impacted M3 is crucial in anticipating potential future complications that might affect the adjacent M2

KEYWORDS: Impacted Mandibular third molar, Dental Caries, Periodontal bone loss, External root resorption, CBCT

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INTRODUCTION

Mandibular third molars (M3) may develop vertically in a normal occlusion or in a nonfunctional position, which are known as impacted third molars. [1] M3 impaction may lead to wide range of complications including pericoronitis, periodontal diseases, dental caries, external root resorption (ERR), neoplastic lesions, and odontogenic cysts.[2] Moreover, they may lead to orthodontic, prosthetic problems, as well as temporomandibular joint disorders. [3]

Distal caries in mandibular second molars (M2) is one of the most frequently occurring complication associated with M3 impaction. Impaction creates favorable conditions that promotes the growth of oral bacteria, which are challenging to reach with brushing, leading to caries development in M2 [4,5] Subsequently, this can result in pulpitis or apical periodontitis, necessitating endodontic treatment or even extraction. For so, early detection and evaluation of the caries risk of adjacent M2 might be essential for the prevention of distal caries. [6] The presence of impacted M3 may negatively affect the periodontal health by causing repeated food impaction and collection of food debris between M3 and M2, increasing the risk to develop distal periodontal bone loss (PBL). This undermines the bone support for M2, potentially leading to teeth looseness and, ultimately, may necessitate extraction [7.8] External root resorption (ERR) often occurred in M2 as a result of the pressure exerted by impacted M3 at the contact site. This pressure might lead to pulp inflammation and, eventually, pulp necrosis. [5] Unlike caries or periodontal disease ERR could not be prevented by good oral hygiene. [9]

Occlusal level and angulation of M3 in regard to M2 as well as its relation to the anterior border of the ramus, may all affect the severity of complication affecting M2. [10,11] Various classification systems have been developed for better understanding and describing different patterns of impacted M3. Implanting these classifications can help in determining the treatment plan and prevent various complications. [10,12,13]

Panoramic radiographs have traditionally been used for M3 imaging. [14,15,16] Nevertheless, due to several drawbacks of 2D conventional radiography such as superimposition and overlapping of the adjacent structures, image distortion, and image magnification, CBCT is considered a superior modality. CBCT offers great diagnostic value and higher effectiveness in detecting and diagnosing of complex pathologies compared to 2D radiographic modalities. [17]

A systematic review conducted by Toedtling et al. [18] emphasized the need for further studies involving diverse populations. Thus, the objective of the current study was to assess the frequency of different patterns of impacted M3 and their association with the severity of various complications on the adjacent M2 in sample of Egyptian population using CBCT.

MATERIALS AND METHODS

This retrospective cross-sectional study was approved by the Ethics committee of the faculty of Dentistry Cairo university with code number 170523. Out of 350 CBCT scans, a sample of 246 impacted M3 were selected from Oral and Maxillofacial Radiology department archive, faculty of Dentistry Cairo university. All the patients were referred from Oral and Maxillofacial Surgery department for further evaluation of impacted M3 site in 3-dimensional images prior to extraction, following their initial evaluation with panorama.

The study comprised patients' age ≥ 20 years, with an age range of 20 to 50 years. Only impacted M3 with completely formed roots were included. Patients with missing M2 as well as missing 1st molar or with jaw deformity caused by trauma or any syndromes were excluded. The presence of metallic artifact, blurred images and images cut off to the area of interest that may affect interpretation were also excluded.

CBCT scan

Planmeca imaging system (Planmeca Oy, Helsinki, Finland) was used to scan all the patients with exposure parameters of 400 μm voxel size, 90 kVp and 8 mA for 13.5 sec. The field of view (FOV) varied between 20 x 6 cm and 20 x 10 cm for single and double arches respectively.

Assessment of impacted M3 patterns

Impaction angulation

The angulation of impacted M3 was evaluated according to Quek et al. [19] method based on Winter's classification [20] in sagittal CBCT plane images. This assessment depends on the angle between the long axis of M3 and that of M2. If the angle fell within the range of 10 to -10 degrees, the angulation was classified as vertical impaction. When the angle ranged from 11 to 79 degrees, then it is mesioangular impaction. Horizontal impaction was allocated when the angle ranged between 80 and 100 degrees, whereas distoangular impaction was assigned when the angle ranged between -11 and -79 degrees. Other types, which are less common like inverted and buccolingual have also been observed and documented (Fig.1).

Impaction level

The level (depth) of impacted M3 was also assessed according to Suzuki et al. [21] based on Pell and Gregory's classification, [22] dividing the impaction level into 3 levels A, B, and C. Level A, where the highest point of the crown of M3 is at or above the occlusal plane of M2. While level B, the highest point of the crown of the M3 is located between the occlusal plane and the cemento-enamel junction of the M2. Level C, the highest point of the crown of M3 is located at a lower level than the cemento-enamel junction of M2 (Fig 2).

Impaction class

According to Suzuki et al. [21] and based on Pell and Gregory's classification, [22] the relationship between the impacted M3 and the anterior margin of the ascending ramus was classified into three classes. When the mesio-distal dimension of the

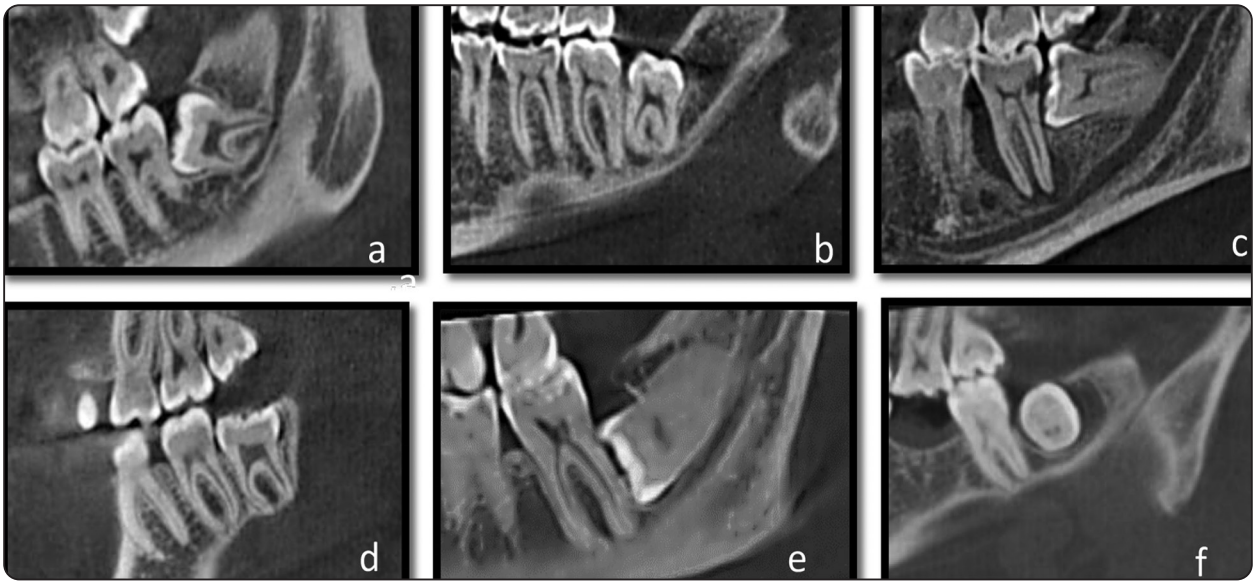

Fig. (1) Showing different angulations of the impacted third molar; a) Mesioangular, b) Distoangular, c) Horizontal, d) Vertical, e) Inverted f) Buccolingual.

M3 is smaller than the distance between the anterior margin of the ascending ramus and the distal surface of M2, it is classified as class I. In class II, the mesio-distal dimension of the crown of the M3 is greater than the distance between the distal surface of the M2 and the anterior margin of the ascending ramus. In class III, the M3 is totally embedded in the bone of the ascending ramus.

Mandibular 2nd molar assessment (M2)

M2 was assessed for the presence of distal caries, distal PBL and ERR (fig. 4).

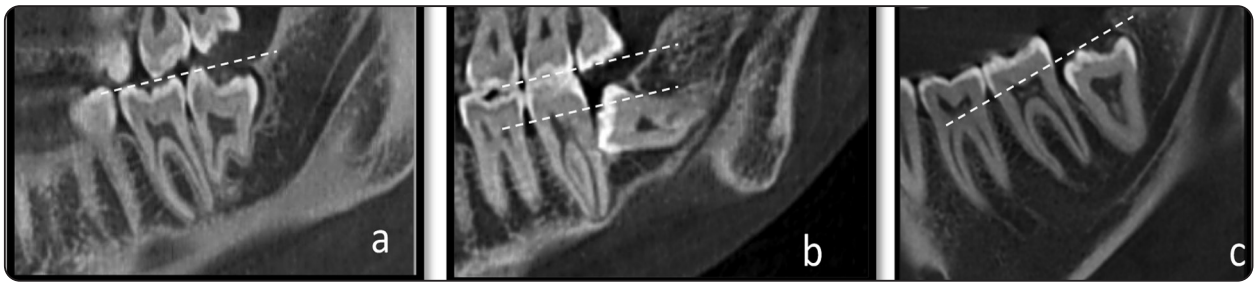

Fig. (2) Showing different levels of the impacted third molar; a) Level A, b) Level B, c) Level C.

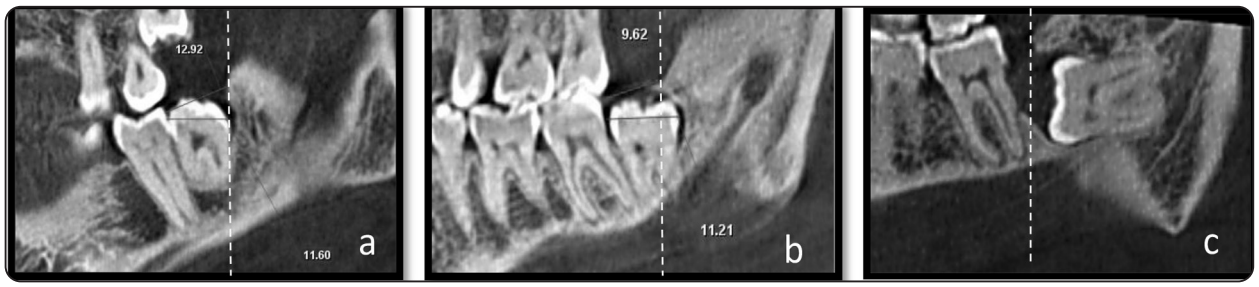

Fig. (3) Showing different classes of the impacted third molar; a) Class I, b) Class II c) Class III. Note; Yellow line indicates the anterior border of ascending ramus facilitating the determination of classes.

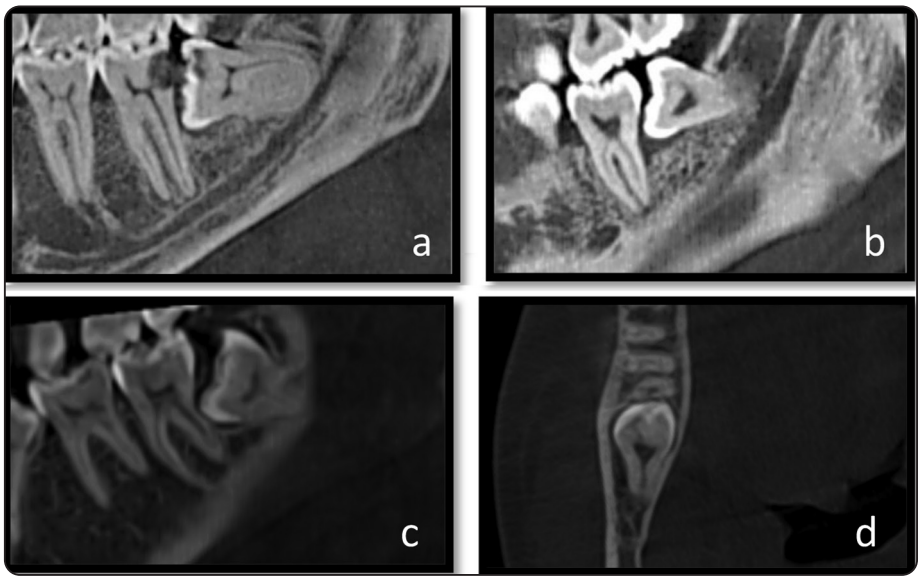

Fig. (4) Showing examples of different complications affecting the mandibular second molar; a) Severe distal caries, b) Moderate distal PBL, c) and d) Moderate ERR.

Caries assessment

The presence of distal caries in M2 was determined when there is distal radiolucency above the cemento-enmel enamel junction and classified into mild (caries limited to enamel), moderate (caries crossed the dentino-enamel junction) and severe (caries reached the pulp).[23]

Distal periodontal bone loss assessment (PBL)

The bone level between M2 and M3 was observed between the distal root of M2 and the mesial root of M3 and categorized qualitatively into, mild bone loss (in the coronal third of the root), moderate bone loss (in the middle third of the root) and severe bone loss (in the apical third of the root). [7]

External root resorption assessment (ERR)

External root resorption (ERR) which appears as a clear loss of dentine and/or cementum in the distal root of adjacent M2 due to direct contact between it and the impacted M3, was classified based on severity into mild, moderate and severe. In mild form, ERR affected less than half of dentine thickness of M2. In moderate ERR, more than half of dentine thickness was affected. When the pulp was involved, it was considered severe ERR.[9,24]

Two experienced maxillofacial radiologists of more than 15 years' experience initially assessed and classified each case separately based on mentioned criteria using different orthogonal cuts, reformatted panorama and 3D rendered volume images (Fig.5). Then they convened to discuss their evaluations, conducted a collaborative image analysis, and reached a consensus on each case.

Sample size calculation

Based on Dias et al.[7] the predicted sample size was (246) impacted third molars by adopting a confidence interval of (95%), a margin of error of (5%), applying finite population correction. Sample size calculation was performed using Epi info for windows version 7.2.

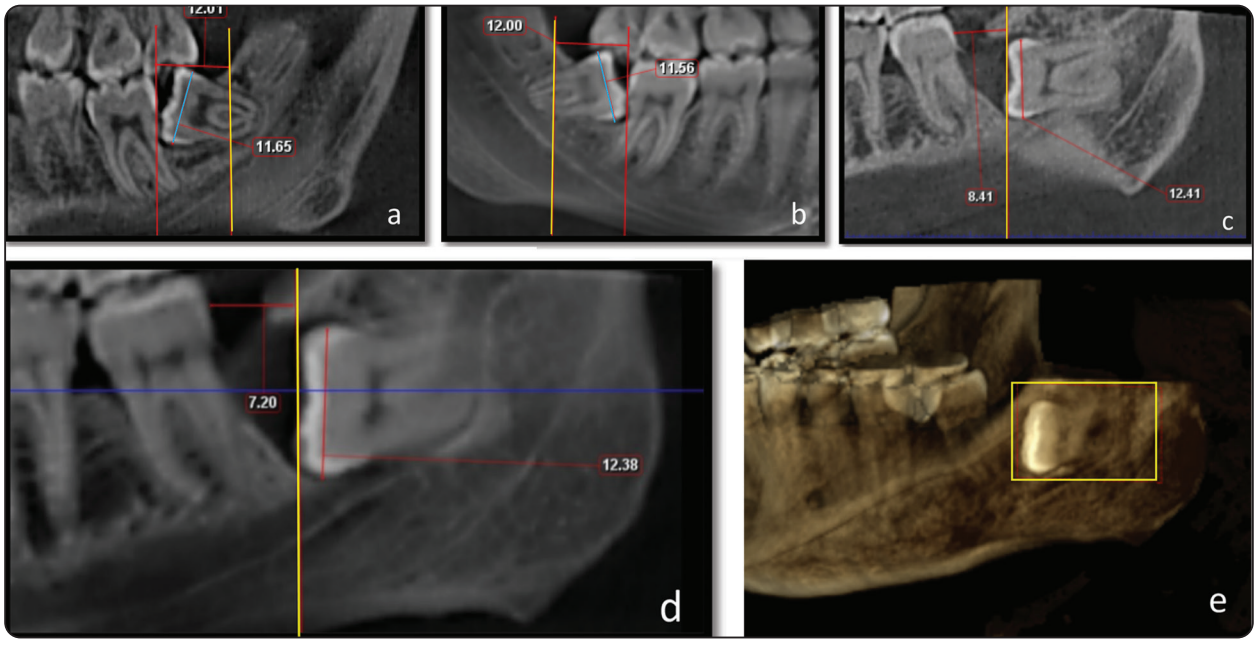

Fig. (5) Showing the harmony between the different images of CBCT scan; a) Sagittal cut and b) Reformatted panorama of the same case impacted third molar showing the mesioangular, level A, class I pattern of impacted third molar. c) Sagittal cut, d) Reformatted panorama, e) 3D volume of the same case showing the horizontal, level C, class III pattern of impacted third molar. Note; Yellow line indicates the anterior border of ascending ramus facilitating the determination of classes.

Statistical analysis:

Categorical data were presented as frequencies and percentages and were analyzed using chi-square test. Exact test was used instead when the expected frequency is less than 5. Numerical data were presented as mean, standard deviation (SD) and range values. They were explored for normality by checking the data distribution and by using Shapiro-Wilk's test. Data showed parametric distribution were analyzed using one-way ANOVA. The significance level was set at $p<0.05$ for all tests. Statistical analysis was performed with R statistical analysis software version 4.3.1 for Windows.

RESULTS

The current study included 246 impacted M3; 105 (42.7%) males and 141 (57.3%) females. The incidence of impaction in females was significantly higher than in males (p=0.025). No significant association was observed between sex and the angulation or level of impaction, yet it was significant between sex and class of impaction with males having significantly higher percentage of class III impactions (p=0.032) (Table 1). Mesioangular impactions had the highest frequency (48%) of all angulation patterns, level A (45.9%) of impaction levels, and class I (59.3%) among different classes.

Concerning the incidence of various complications, (30.9%) of M2 exhibited distal dental caries. The highest percentage of distal caries of M2 was related to mesioangular angulation (68.4%), followed by vertical and horizontal impactions (19.7%) and (10.5%) respectively. The least percentage of carious cases was associated with distoangular impaction (1.3%). Among different levels of impaction, level A was associated with (50%) of distal carious lesions in M2, while, class I counted (63%) of the cases across different classes. (65%) of M2 showed distal PBL, with the highest percentages associated with mesioangular

TABLE (1) Associations between different impaction patterns and gender using Chi-square test.

Pattern	*Gender [n (%)]*		χ^2	*p-value*
	Male	***Female***		
Impaction angulation				
Mesioangular	53 (21.54%)	65 (26.42%)		
Distoangular	8 (3.25%)	16 (6.50%)		
Buccolingual	1 (0.41%)	0 (0.00%)	**6.74**	**0.241**
Vertical	27 (10.98%)	47 (19.11%)		
Horizontal	16 (6.50%)	12 (4.88%)		
Inverted	0 (0.00%)	1 (0.41%)		
Impaction level				
A	50 (20.33%)	63 (25.61%)		
B	41 (16.67%)	56 (22.76%)	**0.33**	**0.847**
C	14 (5.69%)	22 (8.94%)		
Impaction class				
Class (I)	59 (23.98%)	87 (35.37%)		
Class (II)	39 (15.85%)	53 (21.54%)	**6.88**	**0.032***
Class (III)	7 (2.85%)	1 (0.41%)		

χ2= Chi squared test statistic; * significant (p<0.05)

angulation (64%), level B (45%) and class I (54.4%). ERR was detected in (39%) of M2. Mesioangular, level B and class II were strongly associated with ERR with rates of (71.5%), (51%) and (52%) respectively.

The severity of complications that affect M2 vary based on different impactions patterns. There was a significant association between caries severity in M2 and impaction angulation (p=0.002). The highest percentages of mild, moderate and severe caries were associated with the mesioangular angulation impaction at (2.85%), (13.82%) and (4.47%) respectively. No significant association was reported between caries severity of M2 and impaction level (p=0.391) or class (p=0.194) (Table 2) (Fig.6).

There was a significant association between PBL severity in M2 and different patterns of impaction (p <0.001). Moderate PBL had the most frequent representation in all impacted patterns. The highest values of moderate PBL were associated with mesioangular impaction (27.24%), class I (20.73%) as well as level A and B that recorded (15.85%). (Table 3) (Fig.7).

ERR severity in M2 and impaction patterns were shown to be significantly associated (p<0.001). The majority of resorption were mild to moderate. Mesioangular was the most angulation pattern related to mild and moderate ERR at (13.41%) and (12.20%) respectively. While, level B was associated with (9.76 %) of mild and (8.94%) of moderate cases. Class II impaction was associated with moderate and mild cases at (9.76%) and (8.13%) respectively (Table 4) (Fig.8).

Age showed a significant association with the severity of distal caries (p=0.002) and ERR (p=0.007), with severe cases observed in older age patients. Meanwhile, no significant association was reported between distal PBL severity and age (p=0.184) (Table 5).

TABLE (2) Associations between caries severity of M2 and impaction pattern of M3 by Chi-square test.

Pattern	*Caries severity [n (%)]*				χ^2	*p-value*
	No	***Mild***	***Moderate***	***Severe***		
Impaction angulation						
Mesioangular	66 (26.83%)	7 (2.85%)	34 (13.82%)	11 (4.47%)		
Distoangular	23 (9.35%)	1 (0.41%)	0 (0.00%)	0 (0.00%)		
Buccolingual	1 (0.41%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	**35.42**	**0.002***
Vertical	59 (23.98%)	5 (2.03%)	10 (4.07%)	0 (0.00%)		
Horizontal	20 (8.13%)	1 (0.41%)	2 (0.81%)	5 (2.03%)		
Inverted	1 (0.41%)	0 (0.00%)	0 (0.00%)	0 (0.00%)		
Impaction level						
A	75 (30.49%)	5 (2.03%)	22 (8.94%)	11 (4.47%)		
B	66 (26.83%)	7 (2.85%)	20 (8.13%)	4 (1.63%)	**6.30**	**0.39**1
C	29 (11.79%)	2 (0.81%)	4 (1.63%)	1 (0.41%)		
Impaction class						
Class (I)	98 (39.84%)	9 (3.66%)	33 (13.41%)	6 (2.44%)		
Class (II)	66 (26.83%)	4 (1.63%)	12 (4.88%)	10 (4.07%)	**8.65**	**0.19**4
Class (III)	6 (2.44%)	1 (0.41%)	1 (0.41%)	0 (0.00%)		

χ2= Chi squared test statistic; * significant (p<0.05)

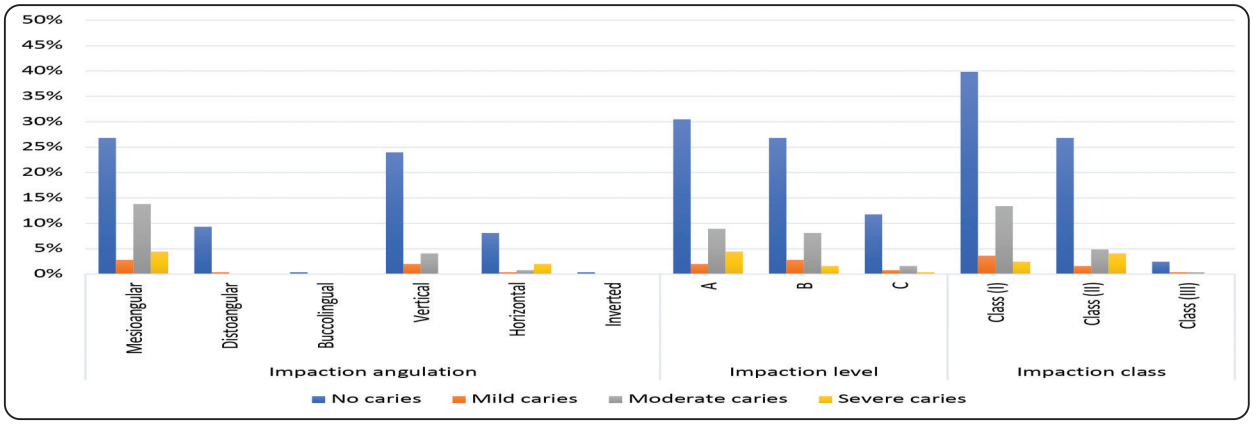

Fig. (6): Stacked bar chart showing the association between different impaction patterns with caries severity of M2.

TABLE (3) Associations between PBL severity of M2 and impaction pattern of M3 by Chi-square test.

Pattern	*Periodontal bone loss severity [n (%)]*				χ^2	*p-value*
	No	***Mild***	***Moderate***	***Severe***		
Impaction angulation						
Mesioangular	15 (6.10%)	13 (5.28%)	67 (27.24%)	23 (9.35%)		
Distoangular	21 (8.54%)	3 (1.22%)	0 (0.00%)	0 (0.00%)		
Buccolingual	1 (0.41%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	**130.43**	**< 0.001***
Vertical	48 (19.51%)	15 (6.10%)	11 (4.47%)	0 (0.00%)		
Horizontal	1 (0.41%)	2 (0.81%)	17 (6.91%)	8 (3.25%)		
Inverted	0 (0.00%)	0 (0.00%)	0 (0.00%)	1 (0.41%)		
Impaction level						
A	53 (21.54%)	17 (6.91%)	39 (15.85%)	4 (1.63%)		
B	25 (10.16%)	14 (5.69%)	39 (15.85%)	19 (7.72%)	**26.82**	**< 0.001***
C	8 (3.25%)	2 (0.81%)	17 (6.91%)	9 (3.66%)		
Impaction class						
Class (I)	59 (23.98%)	24 (9.76%)	51 (20.73%)	12 (4.88%)		
Class (II)	26 (10.57%)	9 (3.66%)	42 (17.07%)	15 (6.10%)	**27.03**	**< 0.001***
Class (III)	1 (0.41%)	0 (0.00%)	2 (0.81%)	5 (2.03%)		

χ2= Chi squared test statistic; * significant (p<0.05)

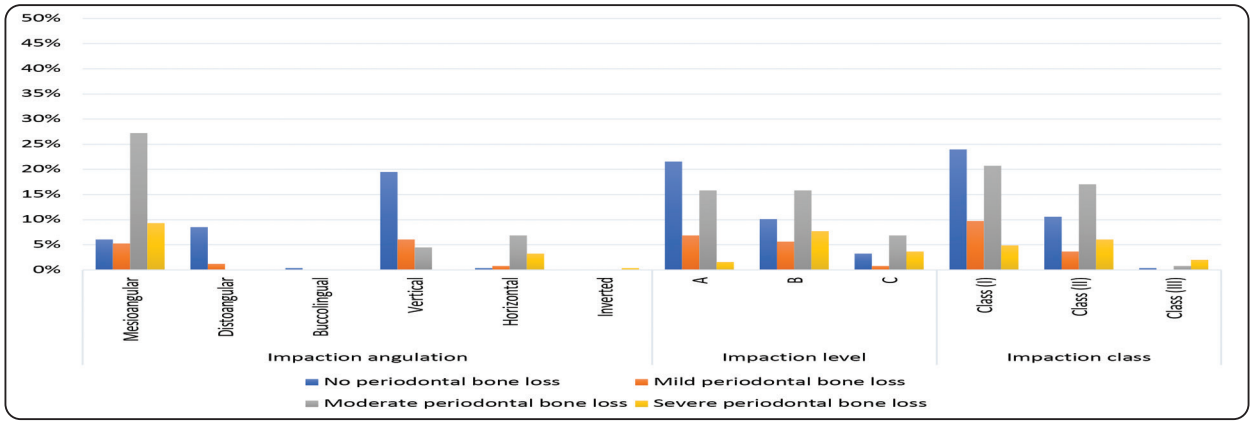

Fig. (7): Stacked bar chart showing the association between different impaction patterns with periodontal bone loss severity of M2.

Table (4) Associations between ERR severity of M2 and impaction pattern of M3 by Chi-square test.

Pattern	*External root resorption severity [n (%)]*				χ^2	*p-value*
	No	***Mild***	***Moderate***	***Severe***		
Impaction angulation						
Mesioangular	47 (19.11%)	33 (13.41%)	30 (12.20%)	8 (3.25%)		
Distoangular	24 (9.76%)	0 (0.00%)	0 (0.00%)	0 (0.00%)		
Buccolingual	1 (0.41%)	0 (0.00%)	0 (0.00%)	0 (0.00%)		
Vertical	70 (28.46%)	3 (1.22%)	1 (0.41%)	0 (0.00%)	**106.36**	**<0.001***
Horizontal	10 (4.07%)	8 (3.25%)	9 (3.66%)	1 (0.41%)		
Inverted	0 (0.00%)	0 (0.00%)	0 (0.00%)	1 (0.41%)		
Impaction level						
A	91 (36.99%)	9 (3.66%)	9 (3.66%)	4 (1.63%)		
B	49 (19.92%)	24 (9.76%)	22 (8.94%)	2 (0.81%)	**39.50**	**<0.001***
C	12 (4.88%)	11 (4.47%)	9 (3.66%)	4 (1.63%)		
Impaction class						
Class (I)	108 (43.9%)	22 (8.94%)	11 (4.47%)	5 (2.03%)		
Class (II)	43 (17.48%)	20 (8.13%)	24 (9.76%)	5 (2.03%)	**35.38**	**<0.001***
Class (III)	1 (0.41%)	2 (0.81%)	5 (2.03%)	0 (0.00%)		

χ2= Chi squared test statistic; * significant (p<0.05)

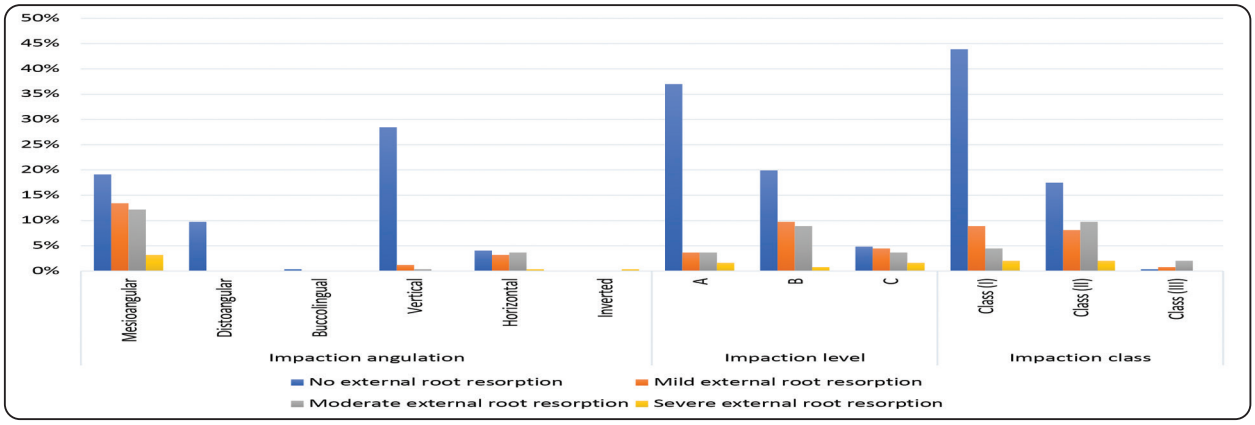

Fig. (8): Stacked bar chart showing the association between different impaction patterns with external root resorption severity of M2.

Table (5) Associations of age with the severity of various complications affecting M2 by one-way ANOVA test.

Parameter	*Age (mean±SD) in different severity groups*				*f-value*	*p-value*
	No	***Mild***	***Moderate***	***Severe***		
Caries	27.25±6.35	25.86±5.10	27.04±6.50	33.38±7.42	**4.98**	**0.002***
Periodontal bone loss	26.81±6.83	26.09±4.09	28.39±6.91	28.41±6.44	**1.63**	**0.184**
External root resorption	27.25±6.42	27.02±5.35	27.42±6.92	34.50±8.51	**4.12**	**0.007***

f= ANOVA test statistic; * significant (p<0.05)

DISCUSSION

Caries, PBL and ERR are commonly reported as M2 complications that arise from different patterns of M3 impaction. These complications might lead to early loss of M2. [25,26] Nevertheless, the decision for extraction of M3 is controversial. Hence, dental professionals must carefully evaluate benefits of its removal against risks before extraction. [11,27,28]

In the current study, the incidence of M3 impaction was significantly higher in females when compared to males (p=0.025). This aligns with many studies. [29-33] while, other studies [34,35] reported a gender predilection towards males. Yet many studies [36-38] reported no significant difference between both genders. The higher frequency in females could be attributed to their small jaw size as their physical growth usually stops earlier than males. [19]

According to our study results, there was no significant association between gender and impaction angulation or level. However, class III impaction was significantly more common in males (p=0.032). Alsaegh et al. [39] found no significant association between angulation and class with gender but they reported a significant association

with level in females experiencing a higher percentage of level C impaction.

Based on our study findings, mesioangular impactions was the most common type of angulation patterns, accounting for (48%). Level A, the most prevalent among impaction levels, represented (45.9%). Class I, the most frequent class, comprised (59.3%). These findings align with numerous studies. [3,9,15,16,18,30,34, 39,40-42] However, according to Ye et al. [32] and Gupta et al. [35] vertical impaction was the most common angulation. Various studies [31,32,34,40] agreed with the current study's finding that Level A is the most common impaction level, others [16,39, 43] reported that level B was the most common. Contrary to these results, Kumer et al. [15] found that level C had the highest frequency. Regarding classes, this study agreed with Kumer et al. [31], identifying class I as the most common. Conversely, many studies [16,34,39, 43] recorded class II as the most common.

According to this study, distal caries was detected in (30.89%) of M2. Chen et al. [6] and Movahhedian et al. [44] reported close values (31.6%) and (26%) respectively. Kang et al. [45] and Şahin et al. [46] recorded higher rates of (52.0%), and (53.5%) respectively while, Tunç and Koc [47] and Akkitap and Gumru [28] reported lower percentages (8.8%) and (3.4 %) respectively.

Food impaction is more likely to occur when third molars are mesioangularly impacted, which increases the risk of M2 distal caries. [41] This is compatible with the current study as the highest incidence of distal caries in M2 (68.4%) was related to the mesioangular impaction. Numerous studies [6, 24, 28, 44, 47] support our results. Level A and B demonstrated high incidence of M2 distal caries (50%) and (40.8%) respectively. Similarly, Akkitap and Gumru [28], Movahhedian et al. [44] and Kang et al. [45] concluded that level A was the most linked class to distal caries of M2. But, Chen et al. [6] noted a higher percentage for level B. In terms of impaction class Movahhedian et al. [44] revealed higher incidences of M2 distal caries were more commonly related to Class I. This is consistent with our findings as Class I accounted for (63%) of M2 carious lesions.

On assessing the distal caries severity of M2, this study concluded that the impaction angulation had a significant association with the caries severity ($p= 0.002$). Moderate caries was the most frequent severity in all impaction, whereas Akkitap and Gumru [28] found that mild caries with was the most common, followed by moderate. Mesioangular, Class I as well as level A and B were the most frequent patterns that associated with moderate caries (13.82%). Similar to our results, Chen et al. [6] revealed that mesioangular angulation impaction increases the severity of distal caries in M2.

The current study results revealed, distal PBL of M2 as the most common pathology caused by impacted M3 with (65%). Dias et al. [7], Ateş Yıldırım et al. [48] and Sarica et al. [49] reported different percentages of (44.4%), (74.1%) and (80%) respectively. In this study, mesioangular impaction was the highest angulation pattern associated with PBL in M2 (64%) followed by horizontal impaction (16.9%). This is consistent with previous studies. [7,48] Although mesioangular impaction significantly increases the risk of PBL, horizontal impaction was also recorded as a high contributor to PBL. [6,44]. Ye et al. [32] concluded that PBL is predominantly related to impaction level due to improper contact with adjacent teeth which worsens the difficulties accompanying with maintaining proper oral hygiene. In this study level B impaction showed the highest incidence of PBL (45%).

Regarding severity, this study recorded a significant association between all impaction patterns and PBL severity of M2 ($p<0.001$) as moderate and severe PBL had the most significant representation.

Dias et al. [7] reported that the moderate severity was the most common PBL type followed by mild. In this study, mesioangular (27.24%), class I (20.73%) as well as level A and B (15.85%) were the most impaction patterns associated with the moderate PBL. Likewise, Ateş Yıldırım et al. [48] noted that mesioangular to increase the severity of the PBL of M2.

Upon assessing the frequency of ERR occurrence in M2, (38.2 %) exhibited ERR. However, its frequency varied across different studies [2,9,15,17, 24,42,47,50-52] as it ranged from (8.5%) to (50.9%). These inconsistencies can be explained on the basis of the different voxel sizes used during CBCT imaging as smaller voxel sizes have been shown to be associated with a better image quality [47].

According to the literature, mesioangular and horizontal impaction are most commonly related to ERR of M2. [2,9,17,50-54] This aligns with our results, which showed ERR in (71.5%) of M2 associated with mesioangular impactions, and (19%) with horizontal impactions. This finding can be explained by the relatively large contact area between the M2 and M3 which tends to exert more pressure causing resorption. [50] Although, horizontally impacted M3 have a larger contact area with the adjacent M2 than mesioangular impaction, the occurrence of ERR resulted from the mesioangular was higher than that of horizontal. This may be attributed to the fact that the applied stress is confined to certain area on the distal surface of the M2. [9] on the other hand, Suter et al. [42] found that the risk percentage for having ERR was high for inverted angulation, followed by horizontal and mesioangular.

In this study, ERR of M2 was observed with the high incidence rates of (51%) in presence of Level B, this is supported by previous studies [2,50], whereas Sakhdari et al. [17] stated that there is no association was observed. Oenning et al. [51] reported that level A and B were associated with ERR of M2 compared with level C while, Li et al. [9] and Gürses et al. [54] reported that level B and C were the most risk factors for ERR.

The current study concluded that there is a significant association between ERR severity of M2 and all impaction patterns ($p<0.001$). In agreement with previous studies [2,42] Mild and moderate ERR were the most presented severities. These severities were related to mesioangular angulation impactions, level B and both class I and II. Smailienė et al. [2] and Sakhdari et al. [17] revealed a significant association between ERR severity and impaction level as well as horizontal and mesioangular impactions respectively. On the other hand, Wang et al. [50] recorded no significant association between the ERR severity and impaction level.

In the present study, a significant association was found between both caries and ERR severity of M2 with age, indicating increase severity in old age. Similarly, many studies [9,50,52] found that the severity of ERR in adjacent M2 increased with age. Conversely, Smailienė et al. [2] and Sakhdari et al. [17] reported that there was no association between the ERR severity and age. Our results can be explained by the non-stop movement of the teeth even after the complete formation of the roots which leads to continuous mechanical pressure on adjacent M2 and ERR progression. [50] A significant association between distal caries severity of M2 and age was recorded by previous studies [35,45,47,55]. Whereas, Chen et al. [6] found no statistically significant association between age and carious lesion severity. The results of this study may be factors such as prolonged exposure time in the oral environment besides other factors such as food impaction and poor oral hygiene, which could contribute to the progression of distal caries with increasing age. [48]

Liu et al. [55], Tai et al. [3] and Yıldırım et al. [33] concluded that the distal PBL severity of M2 increased with the patient age. Nevertheless, in the current study the mean age of patients with

moderate and severe PBL was slightly higher than those with mild PBL with no significant association between bone loss severity and age. This finding may designate that patient living with impacted M3 have a tendency to develop poor prognosis for M2.

The divergence of results along varies studies may be attributed to several factors, including different culture, socioeconomical factors of populations, variations in severity categorization, and difference in sample size calculation.

CONCLUSION

Mandibular 3rd molar is commonly impacted and may negatively affect the adjacent 2nd molar depending on its position. Mesioangular, level A and class I are most common impaction patterns. PBL is the most common pathology caused by impacted M3. The study results highlighted the importance of monitoring M2 adjacent to impacted M3. This aids in prediction of associated risks and to decide whether to maintain or prophylactically remove M3 to preserve M2.

Limitation

In the current study various complications were diagnosed based on radiographs only, lacking additional clinical information.

Declarations

Ethics approval and consent to participate:

The study was approved by the ethic committee, faculty of Dentistry, Cairo university **(code number 170523).**

Consent for publication:

Not applicable.

Availability of data and materials

The datasets used and/or analysed analyzed during the current study are available from the corresponding author on reasonable request.

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Conflict of interest

The authors declare that they have no competing interests.

Author Contributions:

OR. Data collection and analysis + manuscript writing and revision + preparation of figures

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