

Table 2: The prevalence of distal caries in mandibular second molars and its associations with the demographic/radiographic characteristics.

Variable	Total (N=160)	Presence of distal caries of M2M		P value
		Yes (%)	No (%)	
Age (years)				
21-27	48	5(10.4)	43(89.6)	0.1
28-37	80	17(21.3)	63(78.8)	
>37	32	2(6.3)	30(93.8)	
Gender				
Male	98	15(15.3)	83(84.7)	1
Female	60	9(14.5)	53(85.5)	
M3M angulation				
Vertical	25	5(20)	20(80)	0.624
Mesioangular	92	15(16.3)	77(83.7)	
Horizontal	36	3(8.3)	33(91.7)	
Distoangular	5	1(20)	4(80)	
Others	2	0	2(100)	
Impaction depth according to Pell and Gregory				
Level A	83	17(20.5)	66(79.5)	0.143
Level B	56	6(10.7)	50(89.3)	
Level C	21	1(4.8)	20(95.2)	
Contact point localization				
No contact	13	0	13(100)	0.04*
Above CEJ	39	10(25.6)	29(74.4)	
At CEJ	48	9(18.8)	39(81.3)	
Below CEJ	60	5(8.3)	55(91.7)	
Horizontal position				
Buccal	1	0	1(100)	0.327
central	66	7(10.6)	59(89.4)	
Lingual	93	17(18.3)	76(81.7)	

*Statistically significant ($p < 0.05$ by Pearson's chi-square independence test (fisher exact test) between categorical variables)

Multivariate logistical regression analysis revealed that contact point at or above the CEJ of M2M was identified as a risk factor for distal caries in M2Ms (contact point above the CEJ; OR:3.95, contact point below the CEJ; OR : 2.23),(Table 3) however, the odd ratio was statistically significant with contact point "above CEJ" p value <0.05 and non-significant with "at CEJ". Lingual horizontal position of M3Ms had (OR: 1.33) more

likely to cause distal caries in M2Ms when compared with M3M in the central position ($p > 0.05$). Mesioangular and distoangular M3M impaction showed increased risk of M2M distal caries (OR: 1.11 and 1.1 respectively) although not statistically significant.

Horizontal position showed reduced risk or protective effect to caries OR:0.451, all p value >0.05 (Table 3).

Table 3: Logistical regression analysis for identified risk factors for distal caries in M2Ms.

Variable	OR	95% CI of OR		p value
		Upper	Lower	
Contact point localization				
Below	1			0.036
Above	3.948	1.097	14.21	

At	2.225	0.678	7.3	0.187
Horizontal position of M3M				
Median	1			
Lingual	1.331	0.484	3.661	0.58
M3M angulation				
Vertical	1			
Mesioangular	1.105	0.318	3.835	0.875
Horizontal	0.451	0.09	2.259	0.333
Distoangular	1.077	0.083	13.981	0.955

Comparison of the severity of carious lesions on M2M among groups classified according to the radiographic characteristics showed no significant difference in studied groups, P value >0.05 (Table 4).

Table 4: Comparison of the severity of carious lesions on M2M among groups classified according to the radiographic characteristics by the Kruskal-Wallis test or Mann-Whitney U test.

Variable	n	Frequency at each severity score			Mean rank	P value
		Class I	Class II	Class III		
Age (years)						
21-27	5	1	2	2	11.3	0.89
28-37	16	1	9	6	12	
>37	2	0	1	1	13.75	
M3M angulation						
Vertical	5	2	1	2	9.9	0.726
Mesioangular	14	0	8	6	13	
Horizontal	3	0	2	1	12	
Distoangular	1	0	1	0	8.5	
*Other						
Contact point localization						
Above CEJ	10	1	5	4	12	0.07
At CEJ	8	1	6	1	8.94	
Below CEJ	5	0	1	4	16.9	
Horizontal position						
Median	6	0	2	4	15.5	0.1
Lingual	17	2	10	5	10.76	
*Buccal						
*Other group and buccal group were omitted due to insufficient data						

DISCUSSION

This study was conducted on a Saudi population in Madinah using CBCT radiography to assess the prevalence of distal caries and the degree of its severity on the the distal surface of the M2M and correlate this with the eruption and position of the mandibular third molars. In this study, the prevalence of distal caries in M2Ms adjacent to the M3Ms was 15% which was lower compared to other studies using CBCT. This may be due to the fact that the CBCT radiographs had been taken for

different diagnostic purposes by several departments such as oral surgery, prosthodontics, endodontics, and orthodontics. Therefore, the third and second molars involved may be asymptomatic with fewer chances for distal caries involvement. In a CBCT study by Jajashree et al., a total of 45% of M2Ms had distal caries associated with impacted M3Ms [18]. However, the sample size involved was 35 patients which is too small for the results to be reliable. Another study conducted in a Chinese population using 500 CBCT images found the prevalence of distal caries in the M2M to be 52% [19].

The authors reported this high percentage to be caused by patients not seeking dental services until their teeth exhibit symptoms and therefore the majority of third molars were symptomatic displaying swelling of the gingiva and sensitivity or pain related to the third or second molars. This may cause M2Ms with distal caries to be more likely included in the study [19]. Another CBCT study conducted by Chen et al. on 421 Chinese patients found the prevalence of distal caries in M2Ms associated with M3Ms to be 31%. The authors claim that this lower percentage is more representative of the Chinese population compared to the previous study as the CBCT images were randomly selected from an archive referred from all departments in the hospital [13].

The most common type of impaction in this study was recorded to be mesio-angular which is supported by other studies on the Saudi population [20-23] and other studies elsewhere [18,24,25]. Contact point localization was found to be associated with the presence of distal caries in M2Ms more than other variables. Contact point above the distal CEJ of M2Ms or at CEJ was associated with distal caries. This is in agreement with the study by Jajashree et al. where they reported that contact point at the CEJ was associated with a higher risk of distal caries [18]. Another study found that distal caries was more likely to be present when the contact point was at or below the CEJ identified using panoramic radiographs [26] which is in agreement with another study using CBCT radiographs [13]. This condition seems to favor food impaction and plaque accumulation facilitating caries development in the area.

Age, gender, depth of impaction, mesial angulation and horizontal position of M3M were associated to some degree with distal caries on the M2M although not statistically significant. Although previous studies indicated that the prevalence and severity of distal caries in M2Ms increases with age where older patients have a higher incidence of distal caries, this study found no association between age and distal caries probably due to the low mean age of the sample which is in agreement with the study by Chen et al. and Marques et al. [13, 26]. Similarly, gender was not found to have an association with distal caries in line with previous studies [13, 19] although Falci et al. found male patients have a greater chance of developing distal caries on the M2M [8]. They suggest the reason for this may be that women cared more about their oral health and actively seek dental services more frequently than men. It is crucial to point out that neither this study, or previous studies correlated the effect of oral hygiene, income level, or education level on the prevalence of distal caries. In this study, Pell and Gregory classification level A depth of impaction was more associated with distal caries compared to levels B and C although not statistically significant. This is comparable with the study by Falci et al. where more carious M2M were associated with Level A depth of impaction although not statistically significant [8]. This is logical as Level C depth of impaction would indicate complete enclosure of the crown of the M3M because the crown's position is below the cervical line of the second

molar and hence a lesser degree of association with distal caries on the M2M.

Risk factors for the development of distal caries according to the angle of impaction were mesial or distal while horizontal impaction showed the lowest risk. Mesial or distal angular impaction may expose the distal surface of the M2M to the oral environment. Because the area is difficult to clean, food impaction and plaque accumulation occurs resulting in caries formation on the distal surface of the M2M [24]. If the carious lesion is too large to be restored, extraction of the M3M becomes necessary to enable restoration of the M2M. Therefore, early detection and evaluation of the caries risk of the M2Ms associated with M3Ms is essential for the prevention of distal caries in the M2Ms.

The severity of distal caries on the M2M and its correlation with the eruption and position of the M3Ms was evaluated in this study as the prognosis and treatment of the distal caries on the M2M is dependent on the extent of the lesion [13], however no significant association was found. No other study evaluated the effect of the three-dimensional position of M3Ms on the severity degree of distal caries in M2Ms except for the study by Chen et al. where they found that M3M mesial angulation of 15°-75° increased the severity of distal caries in the M2M [13].

This study was conducted on a Saudi population in the city of Madinah using CBCT radiographs. Including other regions in Saudi Arabia would have the potential benefit of comparison for regional differences. Another limitation of this study was that it did not include clinical verification of caries. Further studies evaluating oral hygiene and socioeconomic status should be conducted to analyze their effects on distal caries on the M2M.

CONCLUSIONS

The null hypothesis stating that there is no correlation between the prevalence and severity of distal caries on the M2M and the degree of eruption and position of the M3M using cone beam computed tomography is partially rejected. Based on the results of this study, impacted M3Ms with a contact point at or above the CEJ of the M2M are associated with distal caries. Clinical risk should influence the decision for prophylactic removal of the M3M. Careful evaluation of the distal caries on the M2M and cautious consideration of the extraction of the M3Ms should be undertaken.

AUTHOR CONTRIBUTIONS

“Conceptualization: D.H. and E.Z.

Methodology: D.H. and E.Z.

Validation: D.H. and E.Z.

Data curation: D.H. and E.Z.

Writing—Original draft preparation: D.H. and E.Z.

Writing—Review and editing: D.H. and E.Z.

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INSTITUTIONAL REVIEW BOARD STATEMENT

The study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the Taibah University College of Dentistry Research Ethics Committee (TUCDREC/13102020/DHashem).

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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