Can the Position of the Impacted Third Molars Be an Early Risk Indicator of Pathological Conditions? A Retrospective Cone-Beam Computed Tomography Study

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ABSTRACT

Objectives: The aim of this retrospective study was to evaluate the prevalence of pathologies associated with impacted third molars in relation to tooth position on cone-beam computed tomography images.
Material and Methods: In 348 cone-beam computed tomography images, the position of 640 impacted third molars (mesiodistal angulation, buccolingual inclination, impaction depth, and contact point localization) and the presence of pathologies (distal caries, external root resorption, marginal bone loss, and pathological follicular space) were evaluated. The data were analysed statistically with a significance level set at $P < 0.05$.
Results: Distal caries was mostly detected in relation to Class A (20.4%) and contact point at (12.5%) and above (10.5%) the cementoenamel junction (CEJ) ($P = 0.000$; $P < 0.05$). External root resorption and marginal bone loss were more common in mesioangular angulation (52.3% and 80.1%, respectively), Class C (53% and 73.8%, respectively), and contact point below the CEJ (53.2% and 73.3%, respectively) ($P = 0.000$; $P < 0.05$). Lingual inclination was identified as a new risk factor for associated pathologies ($P < 0.05$). Pathological follicular space was significantly more likely to occur in those with inverted angulation (100%) and absence of contact (31.5%) ($P = 0.000$ and $P = 0.010$, respectively; $P < 0.05$).
Conclusions: Pathologies arising in second molars in relation to impacted third molars are significantly associated with the three-dimensional position of impacted third molars, and watchful monitoring or prophylactic removal of impacted third molars should be considered, taking into account the relevant risk parameters for the related pathologies.

Keywords: cone-beam computed tomography; impacted tooth; pathology; risk factor; third molar.

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INTRODUCTION

Third molars often fail to erupt partially or completely in the dental arch within the expected period (between 18 and 24 years of age) and may give rise to several pathological conditions such as distal caries, root resorption, periodontal disease, marginal bone loss in the adjacent second molar, and cysts or tumours [1,2]. Although many researchers have pointed out that there is a relationship between the position of the impacted tooth and the risk of pathology and that the correct assessment of the position plays an important role in the treatment decision for impacted third molars, no general consensus has been reached in this regard [3-5].

Therapeutic extraction of disease-positive impacted third molars, regardless of whether they are symptomatic or asymptomatic, is generally accepted. However, prophylactic extraction of disease-free and asymptomatic impacted third molars still remains a matter of debate. While some researchers claimed that asymptomatic impacted third molars have the potential to trigger pathological changes, others argued that these teeth may remain asymptomatic for a lifetime and post-operative complications should be considered before exposing the patient to such trauma [2,3]. Although these different opinions on the approach to asymptomatic impacted third molars have unintentionally created confusion among oral and maxillofacial surgeons and general dental practitioners, available data such as patient age, position of the tooth, and degree of impaction are generally considered in the decision-making process for assessment of the risk of pathology related to the third molar impaction [6].

While panoramic radiography (OPG) is the first-choice radiographic method for the assessment of impacted third molars and associated pathologies, cone-beam computed tomography (CBCT) is strikingly superior in demonstrating the relationship with adjacent anatomical structures by providing minimal distortion, higher image quality, and no superimposition [7,8]. In the literature review, it was noted that OPG images were used in most of the studies evaluating the pathologies associated with impacted third molars, the number of studies using CBCT images was relatively low, and in most of this limited number of CBCT studies only one or a few pathology types were evaluated [5,7-19]. In addition, only mandibular impacted third molars were included in the only CBCT study in which all pathologies were investigated [19].

Considering all this information together, the aim of this retrospective study was to retrospectively evaluate the prevalence of pathologies associated with impacted maxillary and mandibular third molars on cone-beam computed tomography images in relation to demographic characteristics and tooth position, and to determine the risk factors related to these pathological conditions.

MATERIAL AND METHODS

The design of this retrospective CBCT study was reviewed and approved by the Research Ethics Committee of Marmara University Faculty of Dentistry (protocol number: 2020/93). CBCT images and reports of patients who admitted to the Department of Oral and Maxillofacial Radiology in Faculty of Dentistry, Marmara University (Istanbul, Turkey) between January, 2013 and November, 2020 were retrospectively evaluated.

The CBCT records of approximately 15,000 patients were examined, but only 348 CBCT scans fully met the eligibility criteria. High diagnostic quality CBCT images adequately displaying the relation between the maxillary and/or mandibular impacted third molars and the adjacent second molars of patients who are at least 25 years of age, having all teeth erupted except third molars, and having at least one impacted third molar were included in the study. Care was taken to ensure that at least two-thirds of the roots of the impacted third molars were developed. Second molars with extensive carious lesions affecting more than one surface, crowns or distal restorations, and images with artefacts in which the areas of interest were obscured due to the presence of high-density materials or other reasons were excluded from the study.

The images analysed were obtained using a Planmeca ProMax 3D Mid CBCT unit (Planmeca Oy; Helsinki, Finland) operating at 90 kVp and 10 mA with 0.2 mm voxel and a 16 x 9 cm field of view. The images were stored in the Digital Imaging and Communications in Medicine (DICOM) format and later reconstructed using Planmeca Romexis version 2.92 software (Planmeca Oy; Helsinki, Finland).

Data regarding age and gender were collected from the electronic patient database and the Planmeca Romexis database. Patient age, calculated by subtracting the patient's date of birth from the CBCT imaging date was recorded. Position of the impacted third molars (mesiodistal angulation, buccolingual inclination, impaction depth, and contact point with the second molar) and associated pathologies (distal caries, external root resorption, and marginal bone loss in the second molar, and pathological follicular space around the impacted third molar) were investigated and double-checked by a single observer (M.P.A.). The same medical monitor (NEC MD242C2 24-inch monitor at 1920 × 1200 resolution - Hiliex Advanced Medical Technologies; California, USA) was used for all analyses with a black background and dim lighting.

Intra-observer agreement on the radiographic parameters was determined by calculating Cohen's kappa value by re-evaluating 30 randomly selected CBCT images at an 8-week interval. All Kappa values were calculated to be higher than 0.90.

The mesiodistal angulation was categorized using the modified Archer classification for impacted maxillary third molars and the modified Winter classification for impacted mandibular third molars (Figure 1A) [20-22]. The impaction depth was assessed using the Archer classification modified by Lewus-Butkiewicz et al. [23] in the maxilla and the modified version of the Pell and Gregory classification in the mandible (Figure 1B) [21,23,24]. In the evaluation of the contact point with the second molar, the distal CEJ of the second molar was considered (Figure 1C) [25]. The buccolingual inclination was measured as the angle between the base line (line drawn between right and left inferior border of the mandible, palatal plane in the maxilla) and the tooth axis and recorded for both impacted third molars and adjacent second molars (Figure 2) [26,27]. As shown in Figure 2, buccolingual inclination of the third molar is classified as "buccal" (C and D) if it is greater than the second molar, as "central" (E and F) if it is close (+/-10°) to the second molar, and as "lingual" (G and H) if it is lower than the second molar. While the mesiodistal angulation, impaction depth, and contact point localization were evaluated on sagittal CBCT sections, the buccolingual inclination was evaluated on coronal sections.

The presence and severity of distal caries in the second molars were categorized using a modification of the International Caries Detection and Assessment System (ICDAS) and the International Caries Classification and Management System (ICCMS™) [15,28,29]. External root resorption in the second molar was classified in terms of presence, location, and severity [30] (Figure 3). In the Figure 3, distal caries and external root resorption were categorized as (A and B) slight, involving less than half the dentin thickness, (D and E) moderate, involving at least half the dentin thickness with the pulp lining being unbroken, and (G and H) severe, involving the pulp cavity. Marginal bone loss in the second molar was categorized in terms of presence and severity by measuring the distance from the CEJ to the deepest point of bone defect [16] The obtained measurements were converted into categories of marginal bone loss severity, as follows: slight (3 - 4 mm) (C), moderate (4 - 6 mm) (F), and severe (> 6 mm) (I) (Figure 3). The follicular space around the impacted third molar was evaluated by measuring the distance from the crown to the follicle border, and a follicular space diameter of ≥ 2.5 mm was considered as radiographic pathology [9] (Figure 4).

Statistical analysis

Statistical analysis was performed using the IBM SPSS® Statistics software version 22.0 (IBM Corp.; Armonk, New York, USA). Parametric data were expressed as mean and standard deviation (M [SD]). The statistical difference was set at $P < 0.05$. In addition to descriptive statistical methods (mean, standard deviation, and frequency), Chi-Square (X^2) test, Fisher-Freeman-Halton exact test, and Yates's correction for continuity were used in the comparison of qualitative data.

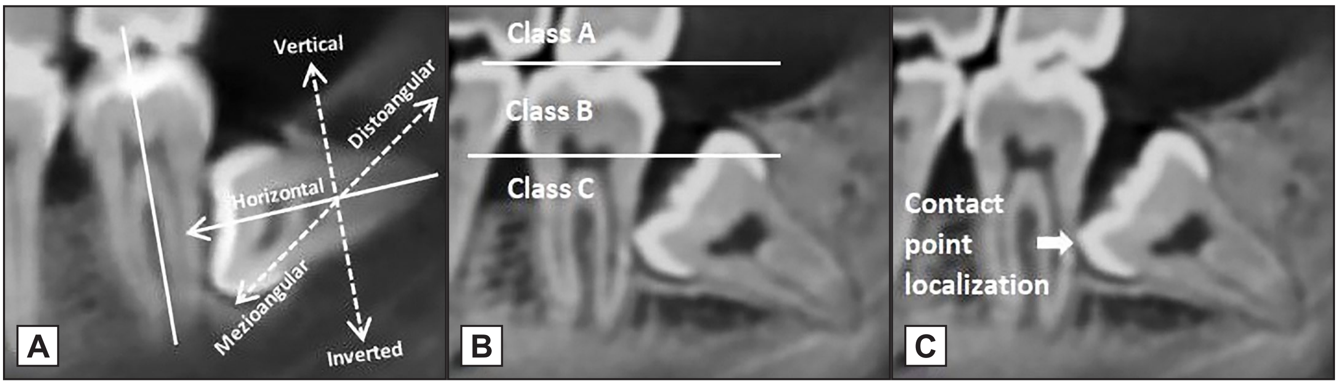

Figure 1. Classification of (A) mesiodistal angulation, (B) impaction depth of the third molar and (C) contact point localization between the third molar and the second molar.

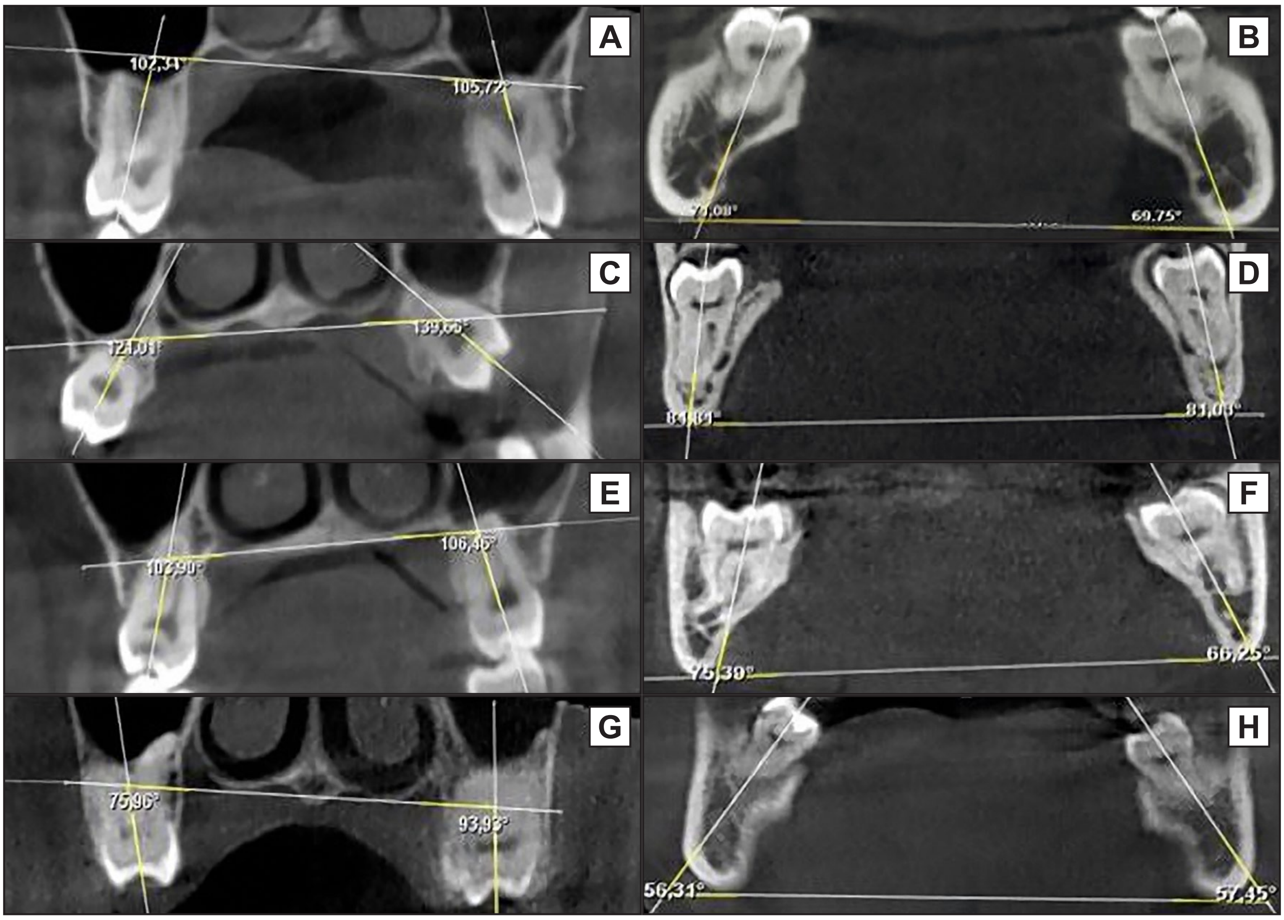

Figure 2. Measurement of the buccolingual inclination of (A) maxillary and (B) mandibular second molar, (C, E and G) maxillary and (D, F and H) mandibular third molar is categorized as buccal (C and D), central (E and F), and lingual (G and H).

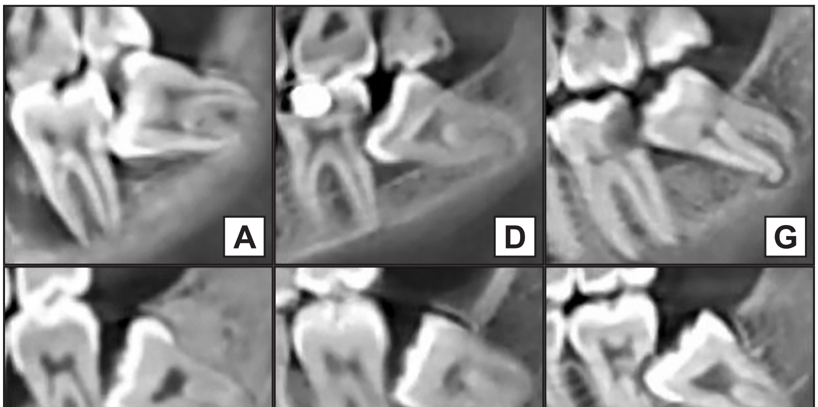

Figure 3. The severity of (A, D and G) distal caries, (B, E and H) external root resorption, and (C, F and I) marginal bone loss in the second molar is classified as (A, B and C) slight, (D, E and F) moderate, and (G, H and I) severe.

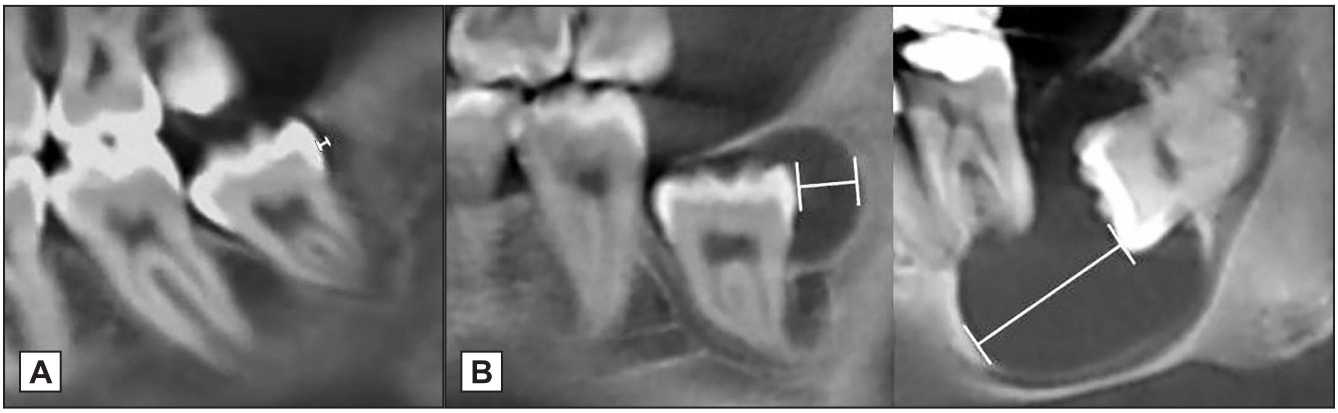

Figure 4. The presence of pathological follicular space around impacted third molar.
A = absent, if the diameter is < 2.5 mm; B = present, if the diameter is ≥ 2.5 mm.

RESULTS

A total of 348 CBCT images belonging to patients with 640 impacted third molars meeting the inclusion criteria of the study constituted the study group. The mean age of the sample was 35.42 (SD 8.74) years (range 25 to 73) with a gender distribution of 180 females (51.7%) and 168 (48.3%) males.

Majority of the patients with impacted third molars were in the 30 to 39 age group (42.2%) ($P = 0.000$; $P < 0.05$). The distribution of the impaction between the two genders was almost equal, with 51.7% females and 48.3% males ($P > 0.05$). The number of impacted mandibular third molars (55.2%) was found to be significantly higher than impacted maxillary third molars (44.8%) ($P = 0.009$; $P < 0.05$). Impacted third molars were 1.2 times more likely to appear in the mandible than in the maxilla (Table 1).

Of a total of 640 impacted third molars included in the study, 541 (84.5%) led to any of the evaluated pathologies and 300 (46.9%) were associated with at least one detectable lesion. The distribution of the presence/severity of distal caries, the presence/localization/severity of external root resorption, the presence/severity of marginal bone loss, and the presence of pathological follicular space associated with impacted third molars are shown in Table 2.

The distribution of pathologies in relation to age, gender, and location is shown in Table 3. The incidence of marginal bone loss and pathological follicular space in males were significantly higher than in females ($P = 0.000$ and $P = 0.003$, respectively; $P < 0.05$). The incidence of external root resorption in the maxilla and the incidence of pathological follicular space in the mandible was detected to be significantly higher ($P = 0.000$; $P < 0.05$).

Table 1. Frequency of impacted third molars in terms of demographic features and jaws (n = 640)

		Impacted third molar		P-value
		Number	%	
Age (years)	25 - 29	224	35	0.000[a]
	30 - 39	270	42.2	
	40 - 49	109	17	
	50 - 59	32	5	
	60 and above	5	0.8	
Gender	Female	331	51.7	0.385
	Male	309	48.3	
Jaw	Maxilla	287	44.8	0.009[a]
	Mandible	353	55.2	

[a]Statistically significant at level $P < 0.05$ (Chi-Square test).

Table 2. Distribution of the pathologies associated with impacted third molars in terms of presence, severity, and localization

			Number	%
Distal caries	Presence	Absent	618	96.6
		Present	22	3.4
	Severity (n = 22)	Slight	9	40.9
		Moderate	8	36.4
		Severe	5	22.7
External root resorption	Presence	Absent	396	61.9
		Present	244	38.1
	Localization (n = 244)	Cervical	49	20.1
		Middle	82	33.6
		Apical	113	46.3
	Severity (n = 244)	Slight	90	36.9
		Moderate	42	17.2
		Severe	112	45.9
Marginal bone loss	Presence	Absent	186	29.1
		Present	454	70.9
	Severity (n = 454)	Slight	67	14.8
		Moderate	129	28.4
		Severe	258	56.8
Pathological follicular space	Presence	Absent	558	87.2
		Present	82	12.8

Table 3. Frequency of the pathologies in terms of demographic features and jaws

		Distal caries	External root resorption	Marginal bone loss	Pathological follicular space
		N (%)	N (%)	N (%)	N (%)
Age (years)	25 - 29	8 (3.6)	71 (31.7)	165 (73.7)	22 (9.8)
	30 - 39	12 (4.4)	108 (40)	188 (69.6)	39 (14.4)
	40 - 49	2 (1.8)	49 (45)	73 (67)	13 (11.9)
	50 - 59	0 (0)	14 (43.8)	24 (75)	7 (21.9)
	60 and above	0 (0)	2 (40)	4 (80)	1 (20)
	P-value	0.65[a]	0.14[c]	0.678[c]	0.201[a]
Gender	Female	9 (2.7)	127 (38.4)	212 (64)	30 (9.1)
	Male	13 (4.2)	117 (37.9)	242 (78.3)	52 (16.8)
	P-value	0.415[b]	0.896[c]	0.000[c]*	0.003[c]*
Jaw	Maxilla	5 (1.7)	132 (46)	208 (72.5)	8 (2.8)
	Mandible	17 (4.8)	112 (31.7)	246 (69.7)	74 (21)
	P-value	0.057[b]	0.000[c]*	0.44[c]	0.000[b]*

[a]Fisher-Freeman-Halton exact test, [b]Yates's continuity correction, [c]Chi-Square test.
*Statistically significant at level P < 0.05.
N = number.

Table 4 shows the relationship between position and related pathologies. Among the different mesiodistal angulation groups of impacted third molars, horizontal (45.7%), mesioangular (52.3%), and inverted (50%) angulations were found to be associated with the highest presence of external root resorption (P = 0.000; P < 0.05). Vertical (76.8%), horizontal (75.5%), and mesioangular (80.1%) impacted third molars were found to be more prone to marginal bone loss (P = 0.000; P < 0.05). In addition, inverted impacted third molars (100%) presented greater risk for pathological follicular space (P = 0.000; P < 0.05).

The presence of external root resorption and marginal bone loss was found to be significantly associated with the buccolingual inclination of the impacted teeth (P = 0.001 and P = 0.000, respectively; P < 0.05) (Table 4). It was noted that impacted third molars with lingual inclination caused significantly higher external root resorption (42.7%) and marginal bone loss (78.2%) in the adjacent second molars (P = 0.001 and P = 0.000, respectively; P < 0.05).

The impaction depth of third molars was also evaluated (Table 4). Class A depth level was associated with a higher prevalence of distal caries in the adjacent second molars (20.4%), while external root resorption (53%), and marginal bone loss (73.8%) were highly observed when the adjacent impacted third molar was in Class C depth level (P = 0.000, P = 0.000, and P = 0.012, respectively; P < 0.05).

As shown in Table 4, a statistically significant relationship was detected between the contact point localization and the presence of all evaluated pathologies (P < 0.05). Contact points at and above the CEJ of the second molar were more likely to cause distal caries (12.5% and 10.5%, respectively) (P = 0.000; P < 0.05). Contact point below the CEJ of the second molar was identified as a risk factor for both external root resorption (53.2%) and marginal bone loss (73.3%) (P = 0.000 and P = 0.01, respectively; P < 0.05). Marginal bone loss (70.9%) and pathological follicular space (31.5%) were also observed at a high rate in cases without contact between the second and third molars (P = 0.01 and P = 0.000, respectively; P < 0.05).

DISCUSSION

This study depicts the associations between the demographic and radiographic characteristics and the presence of pathologies related to third molar impaction. Considering that our faculty is an important reference centre in the diagnosis and management of oral and maxillofacial pathologies and attracts patient populations from various parts of the city and its surroundings, it can be assumed that the study sample represents a random sample of the Turkish population. Therefore, the findings of this study reflecting the prevalence and characteristics of the third molar impaction and associated pathologies in the Turkish population may provide important information and perspectives on the subject under investigation and may guide future research.

Table 4. The relationship between position and pathologies in the maxilla, mandible and maxilla + mandible

		Distal caries presence			**External root resorption presence**			**Marginal bone loss presence**			**Pathological follicular space presence**		
		Maxilla	**Mandible**	**Total**	**Maxilla**	**Mandible**	**Total**	**Maxilla**	**Mandible**	**Total**	**Maxilla**	**Mandible**	**Total**
		N (%)	**N (%)**	**N (%)**	**N (%)**	**N (%)**	**N (%)**	**N (%)**	**N (%)**	**N (%)**	**N (%)**	**N (%)**	**N (%)**
Mesiodistal angulation	Vertical	4 (3.4)	2 (5.7)	6 (4)	31 (26.7)	2 (5.7)	33 (21.9)	98 (84.5)	18 (51.4)	116 (76.8)	2 (1.7)	7 (20)	9 (6)
	Horizontal	0 (0)	5 (5.7)	5 (5.3)	5 (71.4)	38 (43.7)	43 (45.7)	3 (42.9)	68 (78.2)	71 (75.5)	0 (0)	26 (29.9)	26 (27.7)
	Distoangular	0 (0)	4 (5)	4 (2.3)	47 (48.5)	7 (8.8)	54 (30.5)	56 (57.7)	37 (46.3)	93 (52.5)	4 (4.1)	17 (21.3)	21 (11.9)
	Mesioangular	1 (1.5)	6 (4)	7 (3.2)	49 (73.1)	64 (43)	113 (52.3)	51 (76.1)	122 (81.9)	173 (80.1)	2 (3)	22 (14.8)	24 (11.1)
	Inverted	-	0 (0)	0 (0)	-	1 (50)	1 (50)	-	1 (50)	1 (50)	-	2 (100)	2 (100)
	P-value	0.269[a]	0.875[a]	0.598[a]	0.000[a]*	0.000[a]*	0.000[a]*	0.000[b]*	0.000[b]*	0.000[a]*	0.669[a]	0.008[a]*	0.000[a]*
Buccolingual inclination	Buccal	2 (1.4)	0 (0)	2 (1.2)	67 (47.9)	3 (9.4)	70 (40.7)	89 (63.6)	20 (62.5)	109 (63.4)	5 (3.6)	15 (46.9)	20 (11.6)
	Central	1 (1.4)	5 (6)	6 (3.9)	27 (39.1)	12 (14.5)	39 (25.7)	57 (82.6)	41 (49.4)	98 (64.5)	0 (0)	15 (18.1)	15 (9.9)
	Lingual	2 (2.6)	12 (5)	14 (4.4)	38 (48.7)	97 (40.8)	135 (42.7)	62 (79.5)	185 (77.7)	247 (78.2)	3 (3.8)	44 (18.5)	47 (14.9)
	P-value	0.846[a]	0.45[a]	0.154[a]	0.43[b]	0.000[b]*	0.001[b]*	0.004[b]*	0.000[b]*	0.000[b]*	0.294[a]	0.001[b]*	0.273[b]
Impaction depth	Class A	0 (0)	10 (22.2)	10 (20.4)	0 (0)	8 (17.8)	8 (16.3)	3 (75)	23 (51.1)	26 (53.1)	0 (0)	4 (8.9)	4 (8.2)
	Class B	3 (4.2)	6 (3)	9 (3.3)	14 (19.4)	54 (26.7)	68 (24.8)	55 (76.4)	139 (68.8)	194 (70.8)	0 (0)	34 (16.8)	34 (12.4)
	Class C	2 (0.9)	1 (0.9)	3 (0.9)	118 (55.9)	50 (47.2)	168 (53)	150 (71.1)	84 (79.2)	234 (73.8)	8 (3.8)	36 (34)	44 (13.9)
	P-value	0.167[a]	0.000[b]*	0.000[b]*	0.000[a]*	0.000[b]*	0.000[b]*	0.766[a]	0.002[b]*	0.012[b]*	0.294[a]	0.000[b]*	0.553[b]
Contact point localization	No contact	0 (0)	0 (0)	0 (0)	3 (14.3)	9 (8.5)	12 (9.4)	17 (81)	73 (68.9)	90 (70.9)	1 (4.8)	39 (36.8)	40 (31.5)
	Above CEJ	1 (5.9)	3 (14.3)	4 (10.5)	1 (5.9)	3 (14.3)	4 (10.5)	9 (52.9)	9 (42.9)	18 (47.4)	0 (0)	2 (9.5)	2 (5.3)
	At CEJ	2 (6.9)	5 (18.5)	7 (12.5)	2 (6.9)	3 (11.1)	5 (8.9)	25 (86.2)	14 (51.9)	39 (69.6)	0 (0)	3 (11.1)	3 (5.4)
	Below CEJ	2 (0.9)	9 (4.5)	11 (2.6)	126 (57.3)	97 (48.7)	223 (53.2)	157 (71.4)	15(75.4)	307 (73.3)	7 (3.2)	30 (15.1)	37 (8.8)
	P-value	0.056[a]	0.000[a]*	0.000[a]*	0.000[b]*	0.000[b]*	0.000[b]*	0.076[b]	0.003[b]*	0.01[b]*	0.758[a]	0.000[b]*	0.000[b]*

[a]Fisher-Freeman-Halton exact test, [b]Chi-Square test.
*Statistically significant at level $P < 0.05$.
N = number; CEJ = cementoenamel junction.

A precise radiographic assessment is essential in evaluating the possible consequences of impacted third molars. Unlike two-dimensional imaging modalities (OPG, periapical, and bitewing) which have the potential to be misinterpreted due to magnification, distortion, blurring, and superimposition, three-dimensional CBCT images provide diagnostic information in the sagittal, axial, and coronal planes without overlapping of anatomical structures [6,8]. Therefore, comparing the results of our study using CBCT images with previous studies performed using two-dimensional radiographs seems controversial.

In this study, impacted third molars were mostly found in mesioangular angulation (33.8%), as reported in several previous studies [4,12,13,18,19]. However, it should be emphasized that different classification systems were used in the studies, and the modification of the Winter classification used in our study was preferred only by Şahin et al. [4]. In addition, it should also be noted that the term "angulation" was used as "inclination" and angular measurements were formed in many other studies [12,13,18,19]. Hence, it may not be possible to compare the results of studies.

Different from all previous studies that evaluated the "buccolingual position" of impacted third molars, it is important that the "buccolingual inclination" was evaluated in this study [15,27]. The present study revealed that buccal inclination in the maxilla (48.8%) and lingual inclination in the mandible (67.4%) were mostly observed ($P = 0.000$; $P < 0.05$).

When the impacted third molars were classified according to the impaction depth, Class C in the maxilla (73.5%) and Class B in the mandible (57.2%) were mostly detected, as reported in some of the previous studies [12,15]. However, there are also studies reporting that Class A was higher in the maxilla and Class C in the mandible [4,22].

While the rate of contact point below the CEJ was higher in the maxilla (76.7%), no contact rate was found to be higher in the mandible (30%) ($P = 0.000$; $P < 0.05$). Similarly, Schriber et al. [18] reported a higher rate of contact point below the CEJ in the maxilla, however, there are also studies reporting higher rate of contact point above or at the same level with CEJ in the mandible [13,15].

Our study showed that 541 of 640 impacted third molars were related to pathology (84.5%), and the most common pathology was marginal bone loss (70.9%), followed by external root resorption (38.1%), pathological follicular space (12.8%), and distal caries (3.4%). In a similar CBCT study, Movahhedian et al. [19] reported that 278 of 500 mandibular impacted third molars caused pathology (55.6%) and the most common pathology was external root resorption (31.2%), followed by distal caries (26%), and pathological follicular space (2.4%). Although the high incidence of associated pathologies is similar to our study, there are differences in terms of the evaluated jaws, number of teeth, pathologies, and criteria used in the evaluation.

None of the pathologies evaluated in the study were correlated with age ($P > 0.05$), and only marginal bone loss and pathological follicular space were detected to be correlated with gender ($P = 0.000$; $P < 0.05$). Similar results were reported in many previous studies [5,7,14,15,17]. However, there are some studies reporting an increase in the incidence of pathologies with advancing age [10,12,16,18]. In addition, some authors reported a higher incidence of distal caries and external root resorption in males [13,17].

In this study, impacted third molars were detected to cause distal caries at a rate of 3.4%. Similarly, a low incidence of distal caries (8.8%) was reported by Keskin Tunç and Koc [17]. However, an incidence of up to 52% was reported in recent studies [4,10,15]. It must be pointed out that oral hygiene and socioeconomic factors, which are important in understanding caries prevalence, were not taken into account due to the retrospective nature of this study. The severity of distal caries was mostly slight (40.9%), followed by moderate (36.4%) and severe (22.7%), similar to the findings of Chen et al. [15].

In this study, in agreement with Keskin Tunç and Koc [17], no relationship was demonstrated between the mesiodistal angulation and the incidence of distal caries ($P > 0.05$). However, many researchers suggested that the second molars are more prone to distal caries in case of mesioangular impaction of third molars since there is a greater possibility of food impaction [4,10,15]. Confirming the results of Kang et al. [10] and Movahhedian et al. [19], Class A depth level was associated with distal caries (20.4%) probably due to the superior position of the impacted tooth resulting in food impaction ($P = 0.000$; $P < 0.05$). On the other hand, no significant relationship between the depth level of impacted mandibular third molars and the incidence of distal caries in the adjacent second molars were reported by Chen et al. [15]. In the present study, while the contact point at (12.5%) or above the CEJ of the second molars (10.5%) was identified as a risk factor for distal caries ($P = 0.000$; $P < 0.05$), Chen et al. [15] speculated that the contact point below the CEJ (11.7%) facilitated food impaction and plaque retention, increasing the prevalence of distal caries. Most notably, although no distal caries was detected in the second molars in the absence of contact (0%), Keskin Tunç and Koc [17] suggested that the absence of contact between the second molar and the impacted third molar was associated with a significant increase in distal caries (95%).

In the present study, the incidence of external root resorption was found to be 38.1%, consistent with the published data [7,14,17], and the incidence of resorption in the maxilla was almost 14% higher than in the mandible ($P = 0.000$; $P < 0.05$). Keskin Tunç and Koc [17] reported similar findings with a lower prevalence in the mandible (11.6%) in comparison to the maxilla (22%). According to a few CBCT studies, the prevalence of external root resorption in mandibular second molars was significantly higher than in maxillary second molars [12,14]. Regarding the severity of external root resorption, Li et al. [12] found that the severity of external root resorption was higher in the maxillary second molars compared to the mandibular second molars. On the other hand, Keskin Tunc and Koc [17] reported that external root resorption was more severe in the maxillary second molars than in the mandible.

In the present study, horizontal (45.7%) and mesioangular third molars (52.3%) were more frequently associated with external root resorption in the second molars ($P = 0.000$; $P < 0.05$). Previous studies suggested that horizontal and mesioangular impactions were associated with a higher external root resorption frequency in the second molars due to larger contact surfaces or the presence of a gap [5,7,14,17,19]. In addition to these angulations, the deep position of the impacted third molar, such as Class B or C impaction, was associated with a higher frequency of external root resorption frequency in the second molars [7,12,19]. In our study, a higher external root resorption frequency was detected for the contacts below the CEJ (53.2%) compared to the contacts at or above the CEJ (8.9% and 10.5%, respectively) ($P = 0.000$; $P < 0.05$). However, there are also studies reporting that the presence of a contact point at and above the CEJ poses less risk compared to other positions [7,13].

The most common locations of external root resorption were the cervical and apical parts of the roots of second molars (20.1% and 46.3%, respectively). However, there are also studies reporting that the most common sites for external root resorption were cervical [7], cervical and middle [14,17], and apical parts of the roots of the second molars [13].

Similar to other studies, it was observed in our study that marginal bone loss was more prevalent in horizontal impacted third molars, followed by mesioangular and vertical angulations [11,16,31]. Of 454 molars with marginal bone loss, 258 (56.8%) were identified with severe, 129 (28.4%) with moderate, and 67 (14.8%) with slight resorption. However, Dias et al. [16] reported the severity of marginal bone loss as mostly moderate.

In previous studies, radiographic findings were used in the assessment of the pericoronal tissue of impacted third molars [9,19]. Considering a pericoronal radiolucency larger than 5 mm as pathological, Movahhedian et al. [19] reported the incidence of pathological follicular space as 2.4%. In the present study, with reference to Barroso et al. [9], the pathologic follicular space was defined as an area radiographically larger than 2.5 mm in diameter, and the incidence was determined as 12.8%. Pathological follicular space was mostly observed in inverted, followed by horizontal and mesioangular impacted third molars (100%, 27.7%, and 11.1%, respectively). In addition, pathological follicular space was observed to be more common in impacted mandibular third molars in the mesioangular and horizontal position by Barroso et al. [9], and in the horizontal position by Movahhedian et al. [19].

CONCLUSIONS

Most impacted third molars, depending on their position, have the potential to be associated with pathologies that may have detrimental effects on the adjacent second molars and/or themselves. The results of this study support the importance of investigating the position of impacted third molars and their relationship with the adjacent second molars as an important factor in the decision-making process involving removal or maintenance and may be a pioneer for future patient-based treatment planning of impacted third molars by introducing a different approach to the decision of prophylactic extraction.

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