Original Article

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Dentistry Section

Assessment of Maxillary Sinus Floor Topography and Root Position of Maxillary Third Molars using Cone Beam Computed Tomography

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ABSTRACT

Introduction: Maxillary sinuses have variable sizes. Knowledge of anatomic correlation between maxillary molars and sinus floor is essential for preoperative assessment in maxillary essment of posterior teeth.

Aim: To assess maxillary sinus floor topography and root position of maxillary impacted third molar position using Cone Beam Computed Tomography (CBCT) imaging.

Materials and Methods: This retrospective study was conducted on the 1080 CBCT images of the upper jaw of patients admitted to Oral and Dental Diseases Research Centre, Kerman University of Medical Sciences, Kerman, Iran, from March 2015 to December 2018. Among these, CBCT images that had atleast one maxillary impacted third molar were evaluated for the position, number and shape of roots and distance from the sinus floor. Data were analysed by Statistical Package for Social Sciences (SPSS) version 26.0, using the Pearson's Chi-square test.

Results: In the present study, of 1080 CBCT, 100 (9.26%) showed atleast one maxillary impacted third molar. Out of 100 patients, 62% were women and the mean age of samples was 35.73±10.27 years. The roots of 17 impacted molars (13.1%), protruded into the sinus cavity, and 18 (13.84%) of teeth had four roots. Distance from the sinus floor in the left and right-sides were 2.38±0.15 and 2.33±0.17 mm, respectively. Root distance from the alveolar crest in the left and right-sides were 3.40±0.22 and 3.51±0.27 mm, respectively.

Conclusion: The results of the present study showed that roots of 51% of impacted third maxillary molars had a relation with the sinus floor. The most frequent tooth position was mesioangular.

Keywords: Impacted tooth, Maxillary wisdom teeth, Three-dimensional (3D) imaging

INTRODUCTION

The maxillary sinus in adults is a pyramidal paranasal sinus. These sinuses have a base at the lateral border of the nose and apex toward the maxillary zygomatic process [1]. Maxillary sinuses are closely in connection with the root of upper molars [2]. The extension of this sinus in adults is variable, and the roots of molars may project into the maxillary sinus [3]. There is a few millimeters of space between the third upper molar and the maxillary sinus. One of the most common of all dental surgeries is the extraction of third teeth. To diminish the risks and problems, such as penetration [4], oroantral fistulae, or moving the tooth root into the sinus [5], an anatomical evaluation should be performed by radiographic images before surgery [2].

Various radiographic techniques can be used to determine the location of impacted teeth. Clinicians commonly use two-dimensional periapical (intraoral) and panoramic radiographs (extraoral) in dental treatments. Although periapical images have a higher resolution, panoramic radiographs help examine larger areas of more parts of the structures of the maxilla and mandible and the surrounding tissues and locate impacted teeth [6]. However, due to the complexity of the anatomical structures of the oral and maxillofacial regions and their superimposition on each other, it is difficult to see important anatomical areas in two-dimensional images such as panoramic and periapical ones. Therefore, for overcoming these limitations, three-dimensional images such as Cone Beam Computed Tomography (CBCT) have been used in recent years [7]. Studies have shown that in many cases, CBCT can be used for an early diagnosis and convenient treatment for numerous dental pathologies [7-9].

Therefore, CBCT scans are valuable in detecting impacted teeth and their local complications [9]. It is also shown that CBCT devices rendered a lower radiation dose and have a greater resolution than conventional Computed Tomography (CT) scans and were designed for use in dentistry [10]. CBCT images offer precise measurement of buccal and lingual defects due to the absence of superimposition of the structures and allow clinicians to evaluate more precisely, the biological relationship between the maxillary molar roots and the maxillary sinus [1].

Third molars are the most common impacted teeth. The incidence of impacted teeth varies in different populations and ethnic groups [11]. CBCT can help clinicians make a more accurate evaluation of the anatomic correlation between maxillary molars and the floor of the sinus [12]. Due to limited new data [13-15], the present study was conducted to assess the relationship between the roots of the maxillary third molars and the sinus by CBCT.

MATERIALS AND METHODS

This retrospective study was conducted on the CBCTs taken from the upper jaw of patients admitted to a Oral and Dental Diseases Research Centre, Kerman University of Medical Sciences, Kerman, Iran, from March 2015 to December 2018. Total images were taken by Planmeca (KVP 90 and MA 14-10 and exposure time of 12-15 seconds). This research has been confirmed by the Ethics Committee of Kerman University of Medical Sciences (IR.KMU.REC.1395.49). Out of 1080 CBCT images, 100 images that had atleast one maxillary impacted third molar, were selected and evaluated from March 2018 to December 2018.

Inclusion criteria: Images with a natural eruption of the first and second upper molars, complete formation of the root of the maxillary third molars, and complete presence of the third molar and maxillary sinus in the image field were included in the study.

Exclusion criteria: Images of patients who underwent CBCT for pathological causes such as cysts, tumours and temporomandibular joint diseases were excluded from the study.

Study Procedure

All images were evaluated by a previously trained final year dentistry student and examined using Romexis® 3.4.6 software to evaluate the roots of the third maxillary molars, the maxillary sinus, and the cortical border of the sinus floor. The position of the teeth and roots and the number of canals and their shapes were measured. All measurements were performed by Romexis software. The information obtained was entered into a checklist. The position of impacted teeth was categorised by measuring the angle formed between the intersected longitudinal axes of the second and third molars. These classifications included vertical (±10°), mesioangular (+11-70°), distoangular (-11-70), and horizontal (≥71°) [16].

The position of the roots in relation to the sinus walls, the floor of the sinus, and the orientation of the long axle of the tooth were investigated and divided into four types as follows [1]:

Type 0: The roots are not connected to the sinus wall.

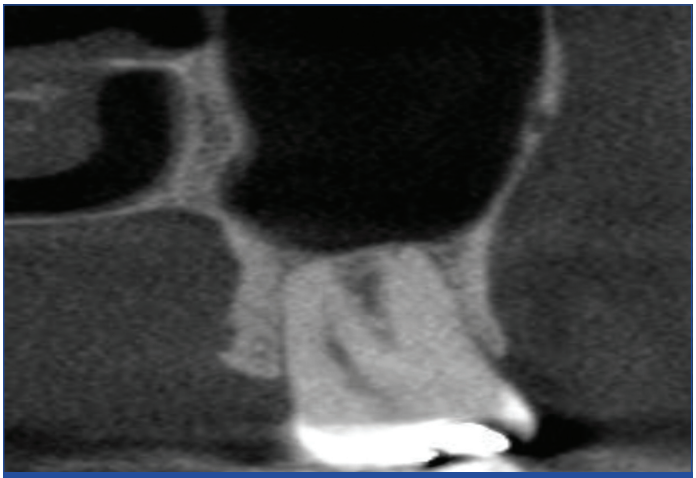
Type I: The roots are connected to the cortical wall of the sinus.

Type II: The root protruded laterally on the sinus cavity, but the apex was outside the borders of the sinus.

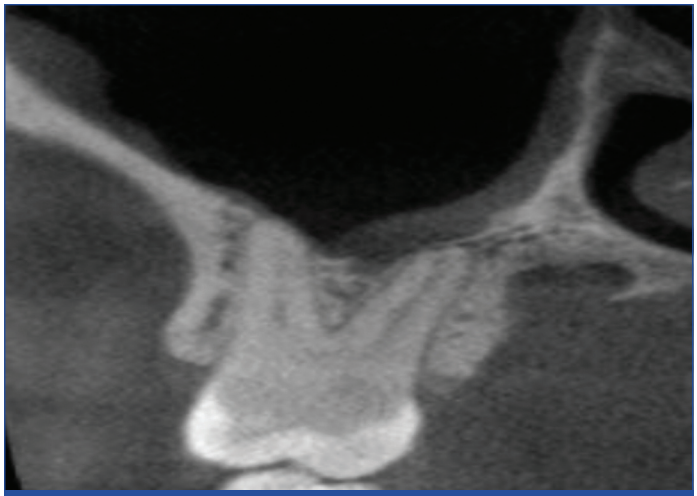
Type III: The roots are also protruding into the sinus cavity [Table/Fig-1-4].

In types 0 and 3, the distance between the tips of the molars and the sinus floor was measured in the cross-sectional section of the CBCT image. The distances were measured from the apex to the cortical inferior wall of the sinus along the longitudinal axis. Positive values were attributed to the extension of the apex below the floor of the sinus, while negative values are attributed to the placement of the apex above the floor of the sinus. The minimum distance between the root below bifurcation and the buccal or palatal cortical plates was measured in the CBCT cross-sectional scans [1]. For each tooth, the root number and shape (fused or separate) were recorded. Roots fusion was defined as a union of two or more separate roots. The roots that were fused, were evaluated as a single root [17].

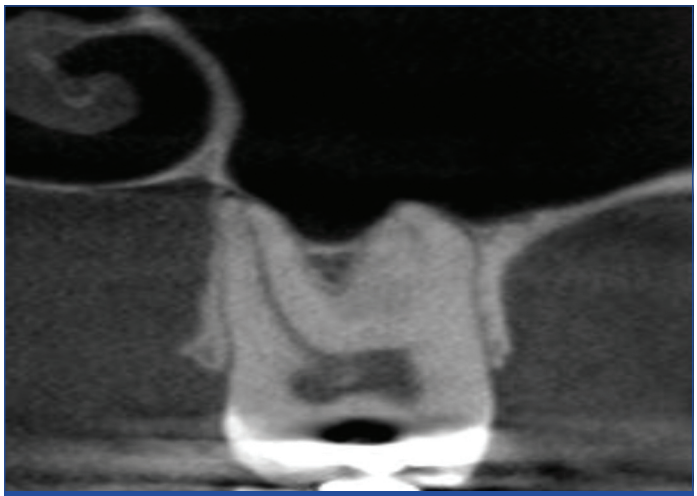
[Table/Fig-1]: Type 0.



[Table/Fig-2]: Type I.



[Table/Fig-3]: Type II.



[Table/Fig-4]: Type III.

STATISTICAL ANALYSIS

Data were analysed by SPSS 26.0, using the frequency distribution tables and figures and the Pearson's χ^2 test for relationship between gender with the number, side, position and root number and shape of impacted teeth.

RESULTS

In the present study, out of 1080 CBCT radiography, 100 scans (9.26%) showed impacted third molars. Out of 1080 images, 616 were women (62 of whom had impacted teeth), and 464 were men (38 of whom had impacted teeth). Although, the impacted teeth in women were more than those in men, but this difference was not significant (p-value=0.38). The average age of samples was 35.73±10.27 years. Out of 100 CBCT scans, 70 patients had one and 30 patients had two impacted teeth and a total of 130 impacted teeth were evaluated.

A 47 (36.15%) of the third molars were located on the right-side, and the most frequent tooth position was mesioangular (39.23%). A 18 (13.84%) of teeth had four roots [Table/Fig-5]. [Table/Fig-6] shows the number of roots on the right, left, and both sides. Most of the teeth with two roots were on the right-side (47.22%), and teeth with one root were equal on the right and left-sides (26.83%). Of the 23 teeth on the left, the most cases (11 teeth, 47.83%) had 1 root.

Variables		Number (n)	Percentage (%)	Total
Side	Left	23	17.7	130
	Right	47	36.15	
	Both	60	46.15	
Position	Horizontal	26	20	130
	Vertical	29	22.31	
	Distoangular	24	18.46	
	Mesioangular	51	39.23	
Root number	1	41	31.54	130
	2	36	27.70	
	3	35	26.92	
	4	18	13.84	
Root shape	Fused	52	40	130
	Separated	35	26.92	
	Unknown	43	33.08	

[Table/Fig-5]: Characteristics of 130 impacted third molars of 100 CBCT images.

Number of roots	Left (n, %)		Right (n, %)		Both (n, %)		Total (N, %)
1	11	26.83	11	26.83	19	46.34	41 (100)
2	4	11.11	17	47.22	15	41.67	36 (100)
3	6	17.14	15	42.86	14	40	35 (100)
4	2	11.11	4	22.22	12	66.67	18 (100)
Impacted molars	23		47		60		130

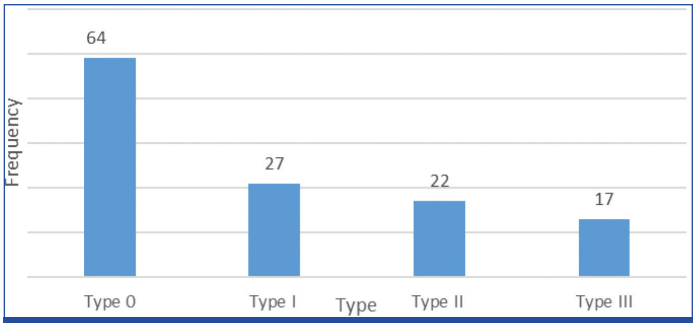
[Table/Fig-6]: Frequency of third maxillary molars according to the number of roots and jaw side.

Also, the relation between gender with the side, position and root number and shape of impacted teeth was not significant (p-value>0.05) [Table/Fig-7]. The relation between the third molars and the maxillary sinus is shown in [Table/Fig-8]. Out of the 130 teeth examined, 64 (49%), were not in relation to the sinus wall, and 17 (13.1%) protruded into the sinus (Type III).

The mean and standard deviation of the distance between roots from the left and right sinuses was 2.38±0.15 and 2.33±0.17 mm, and the distance between the left and right alveolar crests was 3.40±0.22 and 3.51±0.27 mm, respectively [Table/Fig-9].

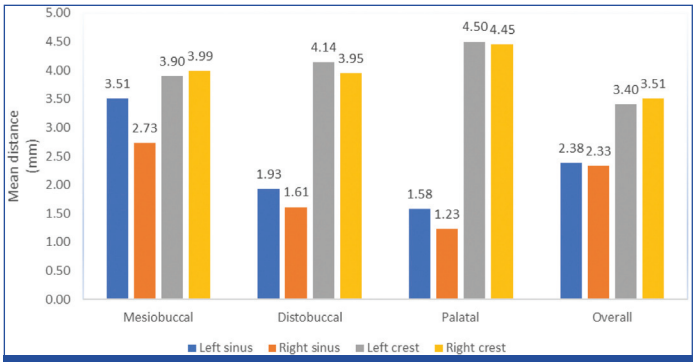
Variable		Male number (%)	Female number (%)	p-value*
Side	Left	9 (23.7)	14 (22.6)	0.71
	Right	16 (42.1)	31 (50.0)	
	Both	13 (34.2)	17 (27.4)	
	Total	38 (100.0)	62 (100.0)	
Position	Horizontal	8 (21.1)	12 (19.4)	0.93
	Vertical	9 (23.7)	13 (21.0)	
	Distoangular	6 (15.8)	13 (21.0)	
	Mesioangular	15 (39.5)	24 (38.7)	
	Total	38 (100.0)	62 (100.0)	
Root Number	1	12 (31.6)	19 (30.6)	0.94
	2	11 (28.9)	17 (27.4)	
	3	9 (23.7)	18 (29.0)	
	4	6 (15.8)	8 (12.9)	
	Total	38 (100.0)	62 (100.0)	
Root shape	Fused	16 (42.1)	24 (38.7)	0.94
	Separated	10 (26.3)	17 (27.4)	
	Unknown	12 (31.6)	21 (33.9)	
	Total	38 (100.0)	62 (100.0)	

[Table/Fig-7]: Characteristic of impacted third molars based on sex.
*Pearson's χ^2 test



[Table/Fig-8]: Relationship of the maxillary third molars with the maxillary sinus.

According to [Table/Fig-6], the largest distance of the sinus among types of third molar roots was related to the mesiobuccal root (3.51 to left sinus and 2.73 to right sinus) and the shortest distance was related to the palatal root (1.58 to left sinus and 1.23 to right sinus).



[Table/Fig-9]: The mean distance between roots of third molars to right and left sinuses and crests.

DISCUSSION

It is necessary to notice the relation between the floor of the maxillary sinus and the roots of the upper molar teeth before dental surgery carefully [2]. The present study demonstrated that the roots of 51% of the teeth were in contact with the maxillary sinus. Many studies have been performed to assess the relationship between the maxillary sinus and posterior upper teeth [1-3,13-15,18-21]. In these studies, different types of classification have been used to examine this relationship. Jung YH and Cho BH showed that 26.5% of the first molars and 23.5% of the upper second molars were associated with the sinus wall [1]. Shahbazian M et al., reported a close relationship between the roots of the first and second molars with sinuses of 54% and 48% by using panoramic radiography and CBCT [20]. However, only some of these researches assessed the relationship between the maxillary third molars and sinus [Table/Fig-10] [2,13-15,21]. This study evaluated the horizontal and vertical relationship and angulation of third molars. The findings showed that the most frequent tooth position was mesioangular, which was similar to Hatem M et al., [15]. However, it is in contrast with Yurdabakan ZZ et al., Demirtas O and Harorli A, Jung YH and Cho BH, Quek SL et al., Hashemipour MA et al., and who showed that the most frequent impaction pattern in the maxilla was vertical position [13,14,21-23].

In present study, 13.1% of the impacted third molars protruded into the sinus (Type III). Jung YH and Cho BH, showed that 32.5% of the mesiobuccal roots of the first molars and 36.7% of mesiobuccal roots of the second molars were prominent inside the sinus [1]. In addition, in the present study, the mean and standard deviation of root distance from the left and right sinuses were 2.38±0.15 and 2.33±0.17 mm, respectively. The largest distance was related to the mesiobuccal root and the shortest distance was related to the palatal root. Jung YH and Cho BH showed that the mesiobuccal root of second molars had the closest distance to the sinus [1]. These differences may be associated with the type of tooth being studied.

Author's name and year	Place of study	Number of subjects	Parameters assessed	Conclusion
Kilic C et al., [2]	Turkey	92 patients (87 right and 89 left maxillary sinus CBCT images)	Distances between the deepest point of the maxillary sinus floor and the root tips of the maxillary first and second premolars and first, second and third molars.	The highest distances were related to premolar, third molar and second molar, respectively for both right and left-sides. Knowledge of these distances is important before surgery of maxillary posterior teeth.
Jung YH and Cho BH [21]	Korea	234 patients (395 upper third molars panoramic radiographs and CBCT images)	The eruption level of the upper third molars, retromolar space, the angulation, the number of roots, and the relationship between the roots and the sinus.	Most impacted had one root. Eruption levels were different based on gender. When panoramic radiographs showed a superimposition of the roots and the sinus floor, CBCT was used to evaluate the root expansion of the sinus to the buccal side of the root .
Demirtas O and Harorli A [14]	Turkey	100 patients (162 impacted third molars CBCT images)	Positions of the maxillary sinus relative to the maxillary third molars, proximity of the roots to the sinus, and angulation and depth of the third molars.	The most frequent tooth position was vertical (59.9%), followed by mesioangular (14.2%), distoangular (9.9%), and others. The connection between the maxillary sinus and the root of the third molar must be considered during extraction.
Hatem M et al., [15]	Libya	300 Orthopantomograms (OPGs) of patients	Prevalence of impaction, angular position, level of eruption and available retromolar space.	Mesioangular impaction was the most frequently angular position, and the majority of impacted third molars (72.7%) had less than adequate space for eruption.
Yurdabakan ZZ et al., [13]	Turkey	394 patients (300 right and 307 left maxillary third molars CBCT images)	The angulation type, depth of the third molars, positions of the maxillary sinus relative to the third molars.	The most common angulation was vertical. Knowledge about relation of the maxillary sinus floor and third molar roots is essential for removing a maxillary third molar.
Present study	Iran	100 patients (130 upper third molars of 100 CBCT images)	The position of the teeth and roots and the number of roots and their shapes.	The most frequent tooth position was mesioangular. About half of the teeth were associated with the maxillary sinus and 13.1% of the teeth were prominent inside the sinus (Type III). The relationship between the maxillary sinus floor and the root apices of the maxillary molars should be considered for treatment planning before surgery.

[Table/Fig-10]: Comparing the results of previous studies regarding the relationship between the maxillary 3rd molars and sinus with the present study [2,13-15,21].

In the present study, 62% of patients were female. This finding is consistent with some studies that showed that the maxillary third molar impaction was more frequent in females [14,21,23]. Whereas some studies have shown no gender preference [11,24]. Yurdabakan ZZ et al., Quek SL et al., and Syed KB, in contrast to the previous investigations and the present study, reported that impacted maxillary third molars were more prevalent in men [13,22,25]. However, the higher prevalence of impacted teeth in women in most studies could be due to the difference in growth pattern in women. Growth in women usually stops, exactly when the third molars grow, while growth in men continues with the growth of the third molars [21].

Now-a-days, knowing the number of roots and their morphology has become more important, because these factors influenced the choice of the surgical method [26]. In the present study, most of the teeth (31.54%) had 1 root, and the least number of the teeth (13.84%) had 4 roots. This is consistent with the finding of Jung YH and Cho BH, in which, one fused root was most prevalent in maxillary third molars (46.1%), pursued by 3 roots and 4 roots (0.8%) were infrequently seen [21]. Differences between studies regarding the proximity of the third molar to the maxillary sinus, the shape and position of the teeth and roots may be due to variation in geographic location, race, the size of the maxillary sinus in different people, sample size, and differences in imaging techniques and classification angulation.

Limitation(s)

The limitation of the present study was that only one private clinic was investigated in a three years period, and as a result, the sample size of impacted third molar teeth was small. Further studies with larger sample sizes are required, to evaluate the maxillary third molars and their proximity to the maxillary sinus using CBCT, given the larger sample size.

CONCLUSION(S)

The present study found that the most frequent tooth position was mesioangular. About half of the teeth were associated with the maxillary sinus and 13.1% of the teeth were prominent inside the sinus (Type III). Knowledge of the relationship between the maxillary sinus floor and the root apices of the maxillary molars is important for treatment planning before surgery. Dentists should be careful when performing procedures, that involve maxillary posterior teeth due to the proximity of the maxillary sinus and the maxillary root tips. The results highlight the need for further research with larger sample size.

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