

3-Dimensional Evaluation of Impacted Mandibular Second Premolars in Association with Surrounding Structures

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ABSTRACT

BACKGROUND AND OBJECTIVE: Mandibular second premolars are the third most frequent impacted. By evaluating the three-dimensional position of the impacted tooth and timely treatment, possible problems and damage to adjacent structures can be prevented. This study was designed to assess the position of Impacted Mandibular Second Premolar (MnP2) as well as the effect on adjacent structures using CBCT imaging due to the lack of adequate studies in this field.

METHODS: This cross-sectional study was performed on 25 impacted mandibular second premolars. Two radiologists assessed and compared CBCT images to determine the following variables: unilateral/bilateral, position of the crown, root resorption of the adjacent permanent teeth, root dilaceration, depth of impaction, type of impaction, pathology incidence, residual primary tooth, position and distance to inferior alveolar nerve canal and the mental foramen.

FINDINGS: In most cases, unilateral impaction was seen (19(76%), $p=0.063$). Crown position of most of MnP2 was displaced lingually (17(68%), $p=0.324$). Vertical and distoangular position of tooth were more common (12(48%) and 5(20%), $p=0.922$). Root resorption of the adjacent permanent teeth and dental pathologies did not occur in any of cases. Most of Mnp2 were categorized under the classification as mild (14(56%), $p=0.270$).

CONCLUSION: According to the results of the present study, it is unlikely that the MnP2 of young patients analyzed in this study would adversely affect adjacent structures.

KEY WORDS: Mandible, Tooth, Impacted, Bicuspid, Cone-Beam Computed Tomography.

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Introduction

Eruptive anomalies make it difficult to achieve optimal orthodontic results (1). An impacted tooth is one that remains in the alveolar bone and its eruption time is significantly delayed because of physiological and pathological barriers (2-4). The third molars are the most commonly impacted teeth (5, 6). Permanent mandibular second premolars (MnP2) are the third most frequent impacted teeth after the upper canines (6, 7). Among the premolars, the MnP2 tooth is the most common premolar. The second maxillary premolars are the second most common (4).

The impacted maxillary first molars are the least common among premolars (8). One possible reason for the greater prevalence of mandibular second premolars is the presence of insufficient space for growth due to late growth after the canine and the second molar (9). The prevalence of impacted premolars varies according to age, race and region (10). Determining the cause of the impaction has a great impact on the treatment process (5).

The causes for having an impacted tooth can be categorized in two groups: local causes and systemic causes. Impaction may be due to local factors. Some of the local causes that can cause tooth impaction are: space deficiency of jaw arches, mesial drift of adjacent tooth, early loss of the first permanent molar, over-retained or ankylosed primary tooth, obstruction of eruption such as supernumerary tooth, trauma, infectious process in the pass of eruption and etc (11, 12). Ankylosed temporomandibular joint, cleft palate, fibrosis dysplasia, Cleidocranial syndrome and Down's syndrome are some systemic factors associated with impactions (9, 13).

According to studies, impacted mandibular second premolars have a high growth potential and are able to grow even in the worst conditions. Treatment options for impacted teeth include observation, intervention (12), surgery with or without orthodontics (14), autotransplantation, surgical repositioning, and extraction of impacted teeth (15, 16). Determining the position of the tooth and having the correct information about the anatomy of the area make the treatment successful (17). Therefore, radiographic evaluation plays an important role in treatment planning (18). Conventional two-dimensional (2D) radiography has limitations in providing sufficient information in impaction cases due to the superimposition of surrounding structures and distortion errors. Cone Beam Computed Tomography (CBCT) is a radiographic modality that produces high-quality diagnostic 3D

images, using lower radiation doses, and allowing reconstruction of scanned structures in different planes. CBCT gives clinician precise information to determine the relationship between the tooth and adjacent structures (5, 19, 20).

In clinical practice, some of orthodontic patients require premolar extraction, thus impacted premolars play an important role in orthodontic treatment and prognosis (21). However, most studies on mandibular second premolars have used panoramic radiographs, examining the tooth only for the prevalence and little information can be obtained from two-dimensional X-rays, such as the distal mesial position of the tooth. A number of other studies have shown that the mandibular second premolar responds to orthodontic or surgical treatment and is occluded despite its poor condition. Therefore, there is no comprehensive and organized information about impacted mandibular second premolars.

Considering that impacted mandibular second premolars are commonly encountered in clinical practice (7), and lack of knowledge regarding the position of tooth, effect on surrounding structure and possibility of occurrence of pathological changes which can affect treatment plan and prognosis, the present study was conducted to evaluate precisely the position of impacted mandibular second premolars (MnP2) as well as their effect on adjacent structures using CBCT imaging.

Methods

CBCT scan of 25 impacted mandibular second premolars of patients (13-30 years old) who referred to the radiology department of Babol University of Medical Sciences were included in this cross-sectional study via convenience sampling (Code of Ethics: IR.MUBABOL.HRI.REC.1397.163). Distorted images that had visual artifacts were removed. In addition, syndromic patients and patients with systemic bone disease were excluded. All CBCT radiographs were scanned by the planmeca 3D (Promax, Helsinki, Finland; field of view of 80×100).

After collecting the required images, evaluation of CBCT images in terms of three-dimensional position of the impacted mandibular second premolar in different coronal, sagittal and cross-sectional sections (0.5 mm thick and 1 mm intervals) was performed by two oral and maxillofacial radiologists. All CBCTs were evaluated on the basis of the following variables: unilateral/bilateral, position of the crown of tooth, root

resorption of the adjacent permanent teeth, root dilaceration (≥ 45 degrees), depth of impaction, type of impaction, pathology incidence, residual primary tooth, position and distance to Inferior Alveolar Nerve Canal (IANC) and the Mental Foramen (MF).

The following definitions (modified Winter's classification) were used to determine the type of impaction: If the angle of the longitudinal axis of the tooth was more than 80 degrees relative to the vertical line and the tooth was in the distal mesial direction, it was considered as Horizontal, if the angle of the longitudinal axis of the tooth with the vertical line was between 11 to 80 degrees, Mesialangular, if the angle of the longitudinal axis of the tooth with the vertical line was between 0 and 10 degrees and the crown was upwards, Vertical, if the angle of the longitudinal axis of the tooth with the vertical line was between 11 to 80 degrees and was distal, Distoangular, if the angle of the longitudinal axis of the tooth with the vertical line was between 0 to 10 degrees and the crown was downwards, Inverted, and if the angle of the longitudinal axis of the tooth was more than 80 degrees relative to the vertical line and the tooth was in the buccal lingual direction, it was considered as Transverse (4).

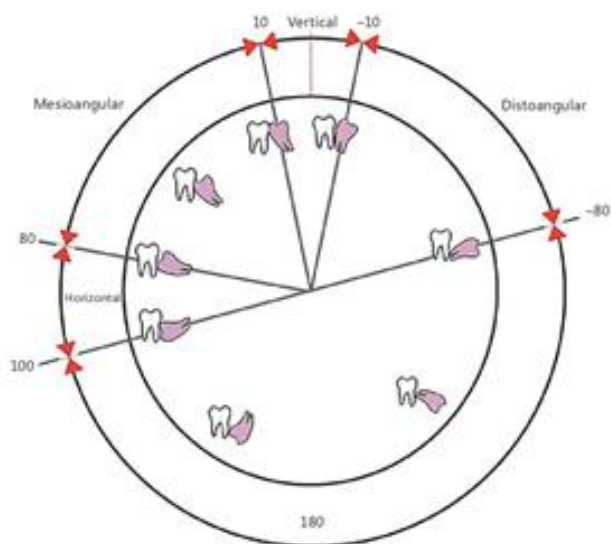


Figure 1. Modified Winter's classification

Modified Brearly's classification was used to determine the depth of impaction: mild, between 0 and 1.9 mm; moderate, between 2.0 and 2.9 mm; and severe, from 3 mm (22). The following modification classification was used to determine the distance to critical structures (IANC and MF): N1 indicates that the nearest part of the impacted tooth from adjacent vital structures is 2 mm or more. N2 indicates that the nearest

part of the impacted tooth from adjacent vital structures is 0 to 2 mm. N3 indicates that the impacted tooth is in the Close position relative to the critical structure (i.e., contact of the root apex with the alveolar canal without loss of the cortical structure of the inferior alveolar canal). N4 indicates that the impacted tooth is in the Tight position relative to the critical structure (i.e., contact of the root apex with the alveolar canal with loss of cortical structure of the inferior alveolar canal) (23).

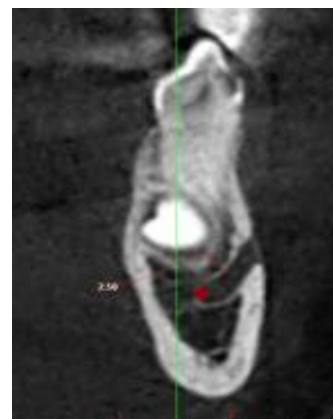


Figure 2. Impacted tooth located more than 2 mm to MF(N1)

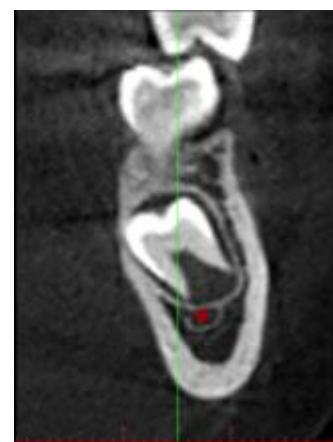


Figure 3. Impacted tooth located Close to IANC (N3)

Data were analyzed using SPSS software version 18 and Chi-Square and Mann-Whitney U tests. Cohens Kappa test was used to assess the intraobserver and interobserver agreement (intraobserver agreement: 0.981, interobserver agreement: 0.989) and $p < 0.05$ were considered significant.

Results

Among 25 patients with a mean age of 16.2 ± 4.80 included in the present study, unilateral MnP2 impaction was seen in most cases (76%, $n=19$). Among

all unilateral cases, 27.36% of them (n=9) had right MnP2 and 30.4% (n=10) had left MnP2 impaction. Information on crown position is presented in Table 1. Impacted mandibular second premolars were Horizontal (n=1, 4%), Mesioangular (n=4, 16%), Vertical (n=12, 48%), Distoangular (n=5, 20%), Inverted (n=2, 8%) and/or Transverse (n=1, 4%). Root resorption of the adjacent permanent teeth was not detected in any of the cases. Root dilaceration was detected in 12% of cases (n=3). Retained primary molars were seen in 24% of MnP2 teeth (n=6). In

52% of cases (n=13), the adjacent permanent teeth were replaced by the impacted tooth. In terms of depth of impaction, (56%, n=14), (20%, n=5) and (24%, n=6) of cases were categorized under the classification of mild, moderate and severe, respectively. Dental pathologies did not occur in any of cases. Data on the association of crown and root of impacted tooth relative to MnP2 to IANC and MF are shown in Table 2 and Table 3, respectively. Furthermore, data on the proximity of MnP2 to IANC and MF are shown in Table 4.

Table 1. Crown position of impacted mandibular second premolars

Section	Buccally Number(%)	Middle Number(%)	Lingually Number(%)	Mesially Number(%)	Vertical Number(%)	Distally Number(%)
Coronal view	5(20)	3(12)	17(68)			
Panoramic view				6(24)	12(48)	7(28)

Table 2. Relation of crown and root of impacted mandibular second premolars to inferior alveolar nerve canal

Section	Superior Number(%)	Inferior Number(%)	Buccally Number(%)	Lingually Number(%)	Parallel Number(%)	Not related Number(%)
Panoramic view						
Crown	16(64)	-				9(36)
Root	14(56)	2(8)				9(36)
Axial view						
Crown			3(12)	7(28)	6(24)	9(36)
Root			6(24)	4(16)	6(24)	9(36)

Table 3. Relation of crown and root of impacted mandibular second premolars to mental foramen

	Mesial Number(%)	Distal Number(%)	Parallel Superior Number(%)	Parallel Inferior Number(%)
Crown	1(4)	14(56)	10(40)	-
Root	4(16)	15(60)	6(24)	1(4)

Table 4. Shortest distance between MnP2* and adjacent structures (modified Brearly's classification)

Distance category	N1 Number(%)	N2 Number(%)	N3 Number(%)	N4 Number(%)
Adjacent Structure				
IANC	8(32)	4(16)	1(4)	12(48)
MF	12(48)	4(16)	1(4)	8(32)

*Impacted Mandibular Second Premolars

N1: Nearest part of the impacted tooth is 2 mm or more from adjacent vital structures, N2: Nearest part of the impacted tooth is less than 2 mm from adjacent vital structures, N3: Impacted tooth is located close to adjacent vital structures, N4: Impacted tooth is located tight to adjacent vital structures

Discussion

In the present study, no pathology was found in any of the cases. According to Ezirganli, at the time of diagnosis, 6.93% of impacted mandibular premolars had cystic lesions (24). In the study of Göksel Şimşek-Kaya, 15.05% of patients had pathologic changes (4). The differences in results may be due to the different age range of the subjects. The previous studies include

patients older than 30 years old, while the oldest included patient in the present study was 28 years old. It seems that pathologic changes are most likely to happen in older ages. Several studies claimed that the unilateral incidence of impacted premolars is greater. Al-Ghurabi et al. have shown that out of the 101 impacted premolars, 97.97% of cases were

unilateral (8). In agreement with previous studies, most of MnP2 occurred unilaterally in the present study (76%). One proposed reason for higher prevalence of unilateral premolar impaction may be the premature loss of the second primary molars as a result of caries at lower ages. This condition may lead to unilateral second premolar impaction consequent to mesial drift of permanent first molar in the mandible. Besides, several studies found no difference in prevalence of right and left impactions, which is similar to the results of this study (25).

The type and depth of impaction have influence on treatment planning. Results of the study by Spyropoulos et al. and Wasserstein et al. showed inclination of the crown of most of impacted second premolars were distally (26, 27). The findings are in agreement with the results of the present study. One possible reason could be that the probability of eruption of mesial inclination of crown is higher. In the present study, most of MnP2 were categorized under mild classification (56%). According to the study by Ezirganli et al., most of impactions were categorized under the classification of moderate (24).

These different results may be due to the fact that their study was performed on both first and second premolar impactions in maxillary and mandibular arches whereas the subjects of our study included specifically the second impacted premolars in the mandible. Unfortunately, no study was found to specifically addressing the depth of impacted mandibular second premolars. In the study of Spyropoulos et al., the most common type of the mandibular second premolar impaction was distoangular and vertical, which is similar to the present study (26).

In the study of Ezirganli et al., which was performed on all the premolar impactions (first and second premolars), the most frequent type of impaction was mesioangular and vertical (24). Mohan et al. state that inverted impaction is rare, which is consistent with the results of the present study in which only 8% of cases were inverted (28). Also, a very small percentage of premolar impactions were transverse (4%). In a study

conducted by Shalish et al., no significant relationship was found between early loss of primary teeth and malposition of MnP2 (29), while Spyropoulos et al. have shown that loss of permanent mandibular first molar can cause MnP2 malposition (26). According to the study of Jain et al., the most common cause of tooth impaction is over retaining of the primary tooth (11). Residual primary teeth were presented in 24% of cases in our study. It seems that early loss of primary teeth could be a local factor for successor tooth impaction, according to several studies (30, 31). Since, most of the time, the early loss of second primary molar causes loss of space arch, it could lead to high possibility of impaction of successor tooth.

According to a study by Miloglu et al., the prevalence of dilaceration in mandibular second premolars (either erupted or impacted) was 4.3% in patients aged 15-65 years (32). In the present study, dilaceration happened in 12% of cases. In only one study, the prevalence of resorption of adjacent teeth by supernumerary impacted premolars was evaluated, showing that only one out of 32 impacted premolars had caused resorption of adjacent tooth (25), which is in line with the results of the present study. The root resorption of the permanent adjacent tooth was not seen in any cases of this study. These findings indicate that the probability of root resorption of the adjacent teeth by impacted premolars is very low.

Most of the impacted MnP2 evaluated in this study were located unilaterally and lingually, and the possibility of pathology in the mandibular second premolars and damage to adjacent structures by them was very low based on this study. It seems that it is very unlikely that MnP2 would adversely affect adjacent structures in young patients.

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