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Pre-operative examination of inferior alveolar nerve and impacted lower third molars relation by panoramic radiography and cone beam computerized tomography: Are panoramic radiographies still standard diagnostic tools for impacted lower third molars?

Alt gömülü yirmi yaş dişlerinin inferior alveolar sinir ile ilişkisinin panoramik radyografi ve konik ışınlı bilgisayarlı tomografi ile operasyon öncesi muayenesi: Panoramik radyografiler alt gömülü yirmi yaş dişler için hala standart tanı araçları mıdır?

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ABSTRACT

Objectives: The aim of this study was to evaluate the compatibility of radiological markers of the impacted lower third molar (LTM) relationship to inferior alveolar nerve (IAN) in panoramic radiographs (PR) with cone beam computerized tomography (CBCT) images.

Materials and Methods: PR and CBCT images of the patients who were referred for LTM removal between September-December 2021 were used. LTM were classified according to the Pederson Difficulty Index in PR. If relation between the teeth and IAN was detected, then CBCT images were investigated to verify the relation.

Results: 52 LTM were included to the study because of having CBCT images. According to Pederson Index 14 teeth were classified as very difficult, 38 as moderately difficult. In PR examination, a relationship with the IAN was observed in 44 teeth. When the CBCT images of 44 teeth were examined, seven of these showed no relationship. On the other hand, when the CBCT images of the eight teeth, which were classified as 'no relationship' in PR images, were examined, it was determined that four of them had relationship. Thus, 41 of the 52 teeth were related to the IAN. The CBCT images of 41 of the 52 teeth confirmed for the proximity of the IAN, 14 of them were classified as very difficult, and 27 of them were classified as moderately difficult.

Conclusion: These findings indicate that if IAN-LTM relation is suspicious according to PR and teeth classified as difficult or very difficult according to Pederson's Index, CBCT is necessary before the surgery.

Keywords: *CBCT, IAN, Impacted lower third molar, Panoramic radiograph*

ÖZET

Amaç: Bu çalışmanın amacı, konik ışınlı bilgisayarlı tomografi (KIBT) görüntüleri ile panoramik radyografilerde (PR) alt gömülü yirmi yaş dişlerinin (AGY) inferior alveolar sinir (IAN) ile ilişkisinin radyolojik belirteçlerinin uyumluluğunu değerlendirmektir.

Gereç ve Yöntemler: Eylül-Aralık 2021 tarihleri arasında AGY çıkarılması için sevk edilen hastaların PR ve KIBT görüntüleri kullanılmıştır. AGY'ler, PR'de Pederson Zorluk İndeksi'ne göre sınıflandırılmış. Dişler ile IAN arasındaki ilişki tespit edilirse, ilişkiyi doğrulamak için KIBT görüntüleri incelenmiştir.

Bulgular: 52 AGY'li 45 hasta, PR yanında KIBT görüntüleri olduğu için çalışmaya dahil edilmiştir. Pederson İndeksine göre 14 diş çok zor, kalan 38 diş ise orta derecede zor olarak sınıflandırılmıştır. Dişlerin PR görüntüleri incelendiğinde 44 dişte IAN ile ilişki saptanmıştır. IAN ile ilişkili 44 dişin KIBT görüntüleri incelendiğinde bu dişlerden yedisinde IAN ile ilişki saptanmamıştır. Öte yandan ilişki yok olarak sınıflandırılan sekiz dişin KIBT görüntüleri incelendiğinde dört tanesinin IAN ile ilişkisi olduğu belirlenmiştir. Böylece 52 dişin 41'i IAN ile ilişkili bulunmuştur. 52 dişin 41'inin KIBT görüntüleri IAN'ın yakınlığını doğrulamış, 14'ü çok zor, 27'si orta derecede zor olarak sınıflandırılmıştır.

Sonuç: Bu bulgular, PR'ye göre IAN-AGY ilişkisi şüpheli ise ve Pederson indeksine göre orta derecede zor veya çok zor olarak sınıflandırılan dişler varsa, ameliyattan önce KIBT çekilmesi gerektiğini göstermektedir.

Anahtar kelimeler: *Alt gömülü yirmi yaş, İnferior alveolar sinir, KIBT, Panoramik radyografi*

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Introduction

The extraction of impacted wisdom teeth is one of the most frequently performed surgical operations in oral and maxillofacial surgery. Like any surgical procedure, the extraction of impacted lower third molars is associated with complications.[1,2] Inferior alveolar nerve (IAN) damage is a serious complication with an incidence varying between 0.6% and 5.3%, This damage is usually temporary and recovers in six months, but in less than %1 cases may be permanent.[3,4] Performing detailed clinical and radiological examination, and complete anamnesis is essential before the operation to minimize complications.[1]

During the radiological examination, the position of the tooth, the morphology of the roots, and the relation with neighboring anatomical structures should be evaluated accurately. Minimizing the risk of nerve damage, requires assessing the position of and relation between the impacted lower third molar roots and the mandibular canal[1]. Panoramic radiographs (PR) are standard diagnostic tool for the radiological examination of impacted lower third molars.[1,2] PR is sufficient to determine the degree of impaction and difficulty of the tooth, and give an idea about the relation of the tooth roots with the IAN.[5] However, some visual parameters of PRs should be carefully undertaken when evaluating the possible relation between the IAN and the lower third molars. These parameters indicating that the third molar roots may be close to the mandibular canal on PR are; the diversion of the mandibular canal, radiolucency at the root tip, diversion of the root, narrowing of the mandibular canal, loss of continuity of the mandibular canal borders, and contact between the mandibular canal and tooth roots.[6]

If the third molar root is on the level of or inferior to the mandibular canal, evaluating the anatomical relation is different because of insufficient information about the buccolingual view and problems such as the superposition of structures, blurred images, and projection errors. To avoid such disadvantages and obtain three-dimensional (3D) images, computerized tomography (CT) or cone-beam computed tomography (CBCT) techniques are used.[1,2,7]

CBCT is preferred in dentistry because of its lower radiation dose, higher regional resolution, affordability, greater detail, and better image quality of the tooth and surrounding structures compared with multidetector computerized tomography.[8,9] With CBCT images, the relation between the roots of impacted lower third molar teeth and the mandibular canal, their relative positions and lingual cortex perforation can be examined more accurately.[10,11]

Particularly, in situations with classic risk signs noted in panoramic imaging, as noted by Rood[6], this 3D examination might be useful not only for risk evaluation but also helps the surgeon to evaluate the difficulty of the surgery and choose the more appropriate surgical technique.[12]

The aim of this study was to evaluate the compatibility of radiological markers of the impacted lower third molar relation to IAN in PR with CBCT images.

Materials and Methods

This retrospective study included 181 participants, selected from the database of Istanbul Okan University Faculty of Dentistry, who were referred to the clinic for extraction of one or more impacted lower third molars between September 2021 and December 2021. The study was approved by the Istanbul Okan University Ethics Committee (153-2022). Patients without CBCT were excluded from the study. The final sample was comprised of 45 patients with 52 impacted lower third molars.

PRs were obtained using Planmeca Promax 2D S3 unit (Planmeca, Helsinki, Finland). The tomography images were acquired by Planmeca, Promax 3D Max (Planmeca, Helsinki, Finland). Images were obtained at 96 kVp, 5.6 mA, and a voxel size of 200 mm with an exposure time of 12 s.

Table 1. Pederson Difficulty Index for removal of impacted lower third molars based on Pell and Gregory and Winter's classifications

Classification	Difficulty Index Value
Inclination of longitudinal axis of the molar	
Mesioangular	1
Horizontal/transverse	2
Vertical	3
Distoangular	4
Depth (with respect to occlusal plane)	
Level A	1
Level B	2
Level C	3
Available space (with respect to ascending mandibular ramus)	
Class I	1
Class II	2
Class III	3

Very difficult: 7-10, moderately difficult: 5-7, minimally difficult: 3-4

Images were evaluated on a standard computer monitor with Planmeca Romexis Viewer software (v4.6.1.R, Planmeca, Helsinki, Finland) by an oral and maxillofacial surgeon and an oral-maxillofacial radiology residency student.

The observers classified the impacted lower third molars according to Winter's classification[13], Pell and Gregory's classification[14], and Pederson Difficulty Index[15] (Table 1) and evaluated the relation between the mandibular canal and the tooth roots according to Rood and Sheba's radiologic signs[6] on panoramic radiographs. Fifteen days later, observers investigated CBCT images. All analyses and classifications were performed independently by each observer. Any disagreements amongst the observers were subsequently resolved after a discussion till both of them reached an agreed conclusion. After a week, 20% of the images (10 images) were reevaluated for the interobserver agreement.

The data were analyzed with Statistical Package for Social Sciences (SPSS) for Windows Version 23 (SPSS V23; IBM® Corporation, Armonk, New York, U.S.A). Interobserver agreement was calculated using kappa statistics. Descriptive and chi-square analyses were used to compare the categorical data. Categorical data was expressed as frequency. The significance level was taken as $p<0.05$.

Results

The study sample was included 52 impacted lower third molars from 45 patients (27 female, 18 male) with an average age of 29.2 years (ranging from 18 to 67 years). The kappa value between the two observers was 0.78 which can be defined as moderate agreement level.

The descriptive statistics, and the relation with the mandibular canal and the accuracy of this relation with CBCT images were summarized in table 2.

Table 2. Descriptive statistics

	n	%
Angulation		
Distoangular	8	15.4
Horizontal	15	28.8
Mesioangular	9	17.3
Vertical	20	38.5
Depth		
A	11	21.2
B	23	44.2
C	18	34.6
Ramus relationship		
Class1	4	7.5
Class2	29	54.7
Class3	20	37.7
Radiolucency at the end of the root		
+	13	25
-	39	75
Loss of the lamina dura		
+	25	48.1
-	27	51.9
Interruption of the canal wall		
+	44	84.6
-	8	15.4
Difficulty index		
Very difficult	14	26.9
Moderately difficult	38	73.1
Relationship with inferior alveolar canal in CBCT		
+	41	78.8
-	11	21.2

According to the Pederson Difficulty Index, 14 teeth were classified as very difficult, and the remaining 38 were classified as moderately difficult. Most of the distoangular and horizontal teeth were classified as very difficult, whereas all the mesioangular and vertical teeth were determined as moderately difficult (Table 3).

Table 3. Comparisons by angulation

	Angulation				
	Distoangular	**Horizontal**	**Mesioangular**	**Vertical**	**p**
Radiolucency at the end of the root					
+	1 (12.5)	6 (40)	1 (11.1)	5 (25)	0.335
-	7 (87.5)	9 (60)	8 (88.9)	15 (75)	
Loss of the lamina dura					
+	3 (37.5)	8 (53.3)	4 (44.4)	10 (50)	0.896
-	5 (62.5)	7 (46.7)	5 (55.6)	10 (50)	
Interruption of the canal wall					
+	7 (87.5)	11 (73.3)	7 (77.8)	19 (95)	0.321
-	1 (12.5)	4 (26.7)	2 (22.2)	1 (5)	
Difficulty index					
Very difficult	6 (75)	8 (53.3)	---	---	<0.001*
Moderately difficult	2 (25)	7 (46.7)	9 (100)	20 (100)	
Relationship with inferior alveolar canal					
+	8 (100)	12 (80)	7 (77.8)	14 (70)	0.376
-	---	3 (20)	2 (22.2)	6 (30)	

p<0.05

When the panoramic radiographs of 52 teeth were examined, a relation with the mandibular canal wall was observed in 44 teeth. When the CBCT images of 44 teeth with interruptions in the mandibular canal wall were examined, seven of these teeth showed no relation with the mandibular canal and it was found that 37 teeth has relation at first examination.

On the other hand, when the CBCT images of the eight teeth, which were classified as 'no relationship' according to PR images, were examined, it was determined that four of them had relation with the mandibular canal. At the end of examinations, 41 of the 52 teeth were related to the mandibular canal.

Of the 41 teeth, 14 (34.2%) were classified as very difficult, and 27 (65.8%) were classified as moderately difficult. According to this evaluation, no statistically significant difference existed between the interruption of the mandibular canal wall and the degree of difficulty, radiolucency in the apical root and loss of the lamina dura (Table 4). The position of the IAN relative to the roots was described in table 5.

Discussion

Neurosensory deficit of the IAN can reduce the patient's quality of life and lead to functional, social, and psychological distress.[9,16] Therefore, assessing the position and proximity of IAN and impacted lower third molar roots is essential before the surgery.[9] PRs are standard diagnostic tools to identify this proximity. PRs can display the dentition and mandible simultaneously, and they have other benefits such as low cost, low radiation dose and convenience.[17]

Table 4. Interruption of the canal wall and the difficulty index relationship

	Interruption of the canal wall		p
	+	-	
Difficulty index			
Very difficult	14 (34.2)	4 (36.3)	1.000
Moderately difficult	27 (65.8)	7 (63.7)	
Radiolucency at the end of the root			
+	9 (21.9)	5 (45.5)	0.396
-	32 (78.1)	6 (54.5)	
Loss of the lamina dura			
+	21 (51.2)	7 (63.6)	1.000
-	1 (12.5)	4 (26.7)	2 (22.2)

$p<0.05$

The radiological signs of this relation were identified by Rood and Shehab.[6] In studies investigating the association of radiological signs in PR and IAN exposure, radiolucency at the root tip was the most significant sign of the IAN exposure and injury.[6,10,18]-21 In this study the most seen radiographic sign of this relation was interruption of the canal wall in accordance with other studies.[6,22]

Table 5. Position of the relationship of the IAN and the roots (CBCT)

	n	%
Inferior	18	43.90
Lingual	12	29.27
Buccal	11	26.83

PRs are very useful and the main technique for IAN examination. However, crucially structures outside the center of rotation of the radiological source and the detector are not sharply imaged and distorted proportionally. Impacted third molars are outside of this center so they may be visualized incorrectly.[23] To visualize the IAN and root relation in a 3D way and make an exact diagnosis CBCT is necessary.[23-25]

In studies comparing the accuracy of panoramic radiographs and CBCT in detecting the relation between the IAN and the impacted lower third molars, CBCT gave better results than panoramic radiographs.[23-27] Similar results were obtained in this study. Relationships that could not be determined by panoramic radiography were determined by CBCT, and the position of the nerve respective to the roots was determined to obtain information to guide the surgeon during the operation.

Another criteria effecting the complication rate and surgery planning that can be obtained from PR is the difficulty of the extraction of the impacted lower third molars.[28,29] Evaluating the difficulty of the surgery is difficult because of the variations of teeth. Several classification systems exist to estimate the surgical difficulty of impacted third molar extraction.[28,29] Pederson proposed a difficulty index for the extraction of the impacted third molars based on radiographic factors.[15] In this study, teeth in which the relationship between IAN and tooth roots were seen in CBCT images were classified as very difficult or difficult according to the Pederson index. Therefore, CBCT, for teeth classified as difficult or very difficult according to the Pederson index, is recommended.

Roeder et al[11]., Peixoto et al[30]. and Akter at al[12].'s studies, the necessity of CBCT before the extraction of impacted lower third molars, reported that the high radiation dose resulting from tomography and did not eliminate the risk of IAN injury. These studies also stated that CBCT should be taken before the extraction of high-risk impacted lower wisdom teet.[11,12,30] In this study, tomography was taken for very difficult and partially difficult teeth for preoperative planning, which supports previous studies.

The position of the impacted lower third molar root relative to the IAN could be a significant risk factor for IAN damage or paresthesia. Some studies, examining the position of the IAN and the impacted lower third molar root on CBCT images, found that the IAN was more often positioned lingually to the roots of third molars than buccally.[31,32] Some found more IANs positioned buccally.[10,17,21,33-35] According to these studies, the risk of exposure increases when the IAN is positioned at the lingual side of the root or interradicular area.[10,33] This could be because surgeons always begin surgery on the

buccal side of the tooth which may cause applying unfavorable extra forces to the lingual side.[10] In this study the IAN was positioned on the inferior (43.9%), lingual (29.27%) and buccal (26,[83]%) sides of the roots. Therefore, the surgeons in this study were especially careful during the extraction of lingual-sided teeth.

Ghaeminia et al[10]. and Roeder et al[11]. compared CBCT to PR, and found that CBCT was not superior to PR. They also reported that CBCT should be performed only in high-risk situations. Other studies[12,23-25,30,36,37], comparing CBCT to PR stated that CBCT is necessary in cases where proximity between the IAN and impacted lower third molar roots was seen. Ghaeminia et al[24]. evaluated the role of CBCT in the treatment of impacted lower third molars that have a relation with the IAN. They concluded that CBCT is necessary in such cases to reclassify a lower risk for IAN injury. Peixoto et al,[30] compared panoramic signs with CBCT images and stated that PR is not the ideal method to evaluate the relation between the impacted lower third molar roots and IAN. Orhan et al.[37] evaluated mandibular third molar region in a Turkish population with CBCT in their study and stated that CBCT images provide useful and unique information regarding impacted lower third molar operations. In this study, in four cases, which were classified as 'no relationship' according to PR images, CBCT images determined that they had a relation with the IAN. Although this was seen in a small number of cases, considering the complications that may occur, it raises the question of whether PRs are the ideal method to evaluate impacted lower third molars.

Conclusion

Before impacted lower third molar extractions, in cases of teeth determined to be high risk for IAN damage, and teeth classified as difficult or very difficult according to Pederson's Difficulty Index, PRs can cause misdiagnosis in some cases as seen in this study so PRs should not be used without the aid of CBCT.

Conflict of interest

None of the authors of this article has any relationship, connection or financial interest in the subject matter or material discussed in the article.

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