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Positional relationship between mandibular third molar and mandibular canal in cone beam computed tomographs

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ABSTRACT

Purpose : To provide diagnostic information by evaluation of the positional relationship between the mandibular third molar and the mandibular canal.

Materials and Methods : Eighty-nine mandibular third molars were classified as mesioangular, horizontal, vertical, distoangular groups. The distances between the mandibular third molar and the mandibular canal were measured in cone-beam computed tomographs. The height and width ratios of distances from the mandibular third molar and the mandibular canal to the mandibular inferior border and to the lingual cortical plate were calculated.

Results : The vertical and buccolingual distances between the mandibular third molar and the mandibular canal were 0.03 mm, 2.96 mm in the mesioangular, 0.37 mm, 3.38 mm in the horizontal, −1.50 mm, 1.38 mm in the vertical, −1.10 mm, 4.20 mm in the distoangular group. There were significant differences in vertical ($P<0.05$), but not in buccolingual ($P>0.05$). The height and width ratios of distances on the mandibular third molar were 47.1%, 36.1% in the mesioangular, 47.4%, 34.4% in the horizontal, 37.0%, 46.7% in the vertical, 40.9%, 37.4% in the distoangular group. There were significant differences between the mesioangular and the vertical group, and the horizontal and the vertical group in height ratio ($P<0.05$), and also between the mesioangular and the vertical group in width ratio ($P<0.05$). The height and width ratios of distances on the mandibular canal showed no significant differences between groups ($P>0.05$).

Conclusion : The mesioangular group showed the nearest distance between the mandibular third molar and the mandibular canal vertically. The root apex of the mandibular third molar was positioned more buccally in the vertical group than in the mesioangular group. (***Korean J Oral Maxillofac Radiol 2007; 37 : 197-203***)

KEY WORDS : Tomography, Cone Beam Computed; Mandibular Third Molar; Mandibular Canal

Introduction

It is important to grasp the location of the mandibular canal on extracting mandibular third molar.[1,2] This is because, with the damage of the mandibular canal can occur, paresthesia and paralysis of the lower lip and perioral region.[3,4] The most frequent cause is partial or complete severance of the nerve during blind use of rotating or other instruments. However, there are other causes, including an inter- or intraradicular path of the nerve, angled roots and compression of the nerve by fragments of the roots or the roof of the mandibular canal if the extraction is done with a lever without sufficient care.[3-5] To prevent its damage, it is necessary to estimate the proximity of the mandibular third molar to the mandibular canal.[6,7]

Panoramic radiographs are frequently used to evaluate the anatomic positional relationship of the mandibular third molar and the mandibular canal. Rood and Noraldeen Shehab[8] arranged 7 radiographic signs concerning the overlapping of the mandibular third molar and the mandibular canal, based on much literature on intraoral radiographs and panoramic radiographs. Of these 7 signs, 3 radiographic signs (diversion of the canal, narrowing of the root, nerve interruption of the white line) are significantly associated with close proximity of the mandibular third molar and the mandibular canal, and nerve injury. Although the mandibular third molar and the mandibular canal appear to contact or overlap one another in panoramic radiographs, there were actually many cases in which teeth were extracted without damage to the mandibular nerve. This is because the panoramic radiographic technique does not always show the buccolingual relationship between the mandibular third molar and the mandibular canal.

There are some reports[9,10] regarding the preoperative evaluation of the relationship between the mandibular third molar and the mandibular canal that have made using intraoral radio-

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graphs, panoramic radiographs, cross-sectional tomographs, scanographs, and conventional computed tomographs. However, previous studies have been performed whether or not to avoid overlap of anatomic structures using intraoral radiographs and panoramic radiographs, as well as whether or not to drop radiographic resolution which lead to image distortion and loss of conventional computed tomographs. They provided limited diagnostic imaging information on the mandible and mandibular canal.[9,10] Recently, with the development of diagnostic imaging fields, cone-beam computed tomography has been introduced and is useful for diagnosis of the oral and maxillofacial region.[11,12] Without distortion of the image on image-reconstruction, high-spacial resolution makes possible the evaluation of complex anatomic structures of maxillofacial and mandibular region.[13-15]

Many previous studies have been reported on the proximity of the mandibular third molar to the mandibular canal, but few include their distance measurements and positional relationships. In this study, mandibular third molars were classified as mesioangular, vertical, horizontal, distoangular, and the distances and height and width ratios were calculated between the mandibular third molar and the mandibular canal within the mandible three-dimensionally. This study could provide diagnostic information preoperatively and aid to minimize postoperative complications on mandibular third molar surgery.

Table 1. Distribution of the age and the gender of patients according to the angulation of the mandibular third molar

Age group	Mesio-angular		Horizon-tal		Vertical		Disto-angular		Total
	M	F	M	F	M	F	M	F	
10-19	0	0	0	0	0	1	0	1	2
20-29	9	6	7	9	4	10	2	4	51
30-39	4	2	5	2	1	4	1	0	19
40-49	1	0	2	2	1	0	0	0	6
50-59	0	0	1	0	0	0	2	0	3
Total	14	8	15	13	6	15	5	5	81

Materials and Methods

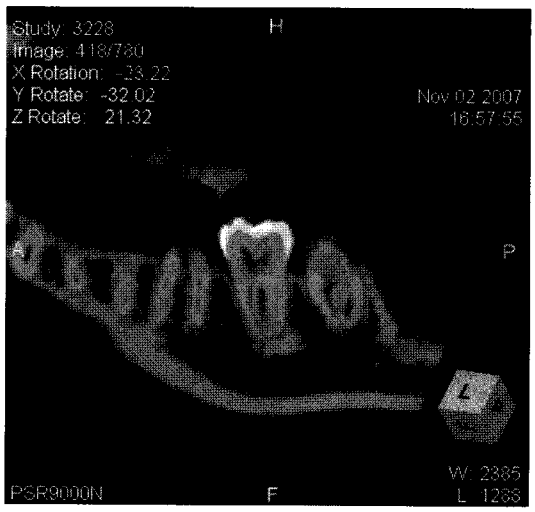
1. Materials

Subjects consisted of 81 patients with impacted mandibular third molars who were treated at the Department of Oral & Maxillofacial Surgery, Chonbuk National University Dental Hospital from January 2005 to May 2007. There were 81 patients (40 males and 41 females), with an average age of 28.0 years (range 19-51 years) (Table 1). Eighty-nine mandibular third molars were classified as mesioangular (24 cases), horizontal (33 cases), vertical (22 cases), distoangular (10 cases) groups. The cases included mandibular third molar with no bony defect, sound mandibular second molar and the existence of maxillary second molar. In the case of premature roots, the bony crypt of the root was observed.

2. Methods

1) Cone beam computed tomographs

Cone beam computed tomographs were performed with a PSR9000N (Asahi Roentgen Co., Japan). Patients were positioned paralls to the official floor with the mandibular inferior border. The sagittal and coronal images were obtained using dental mode at 80 kV, 10 mA, 13.3 seconds. Images were obtained by volume data of cone type with a field size of 40 mm in height and 41 mm in diameter. The sagittal, coronal and 3-D images were evaluated by the Asahivision of 3-D



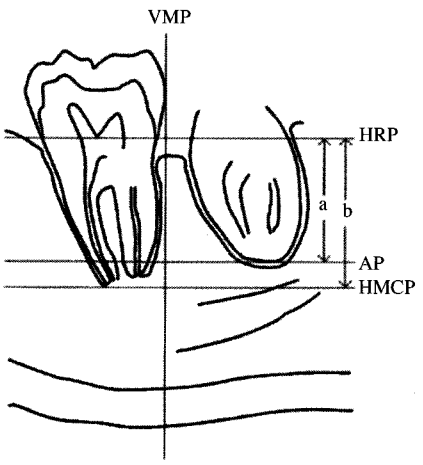


Fig. 1. Reference planes for the positional analysis of the mandibular third molar and the mandibular canal in sagittal image.

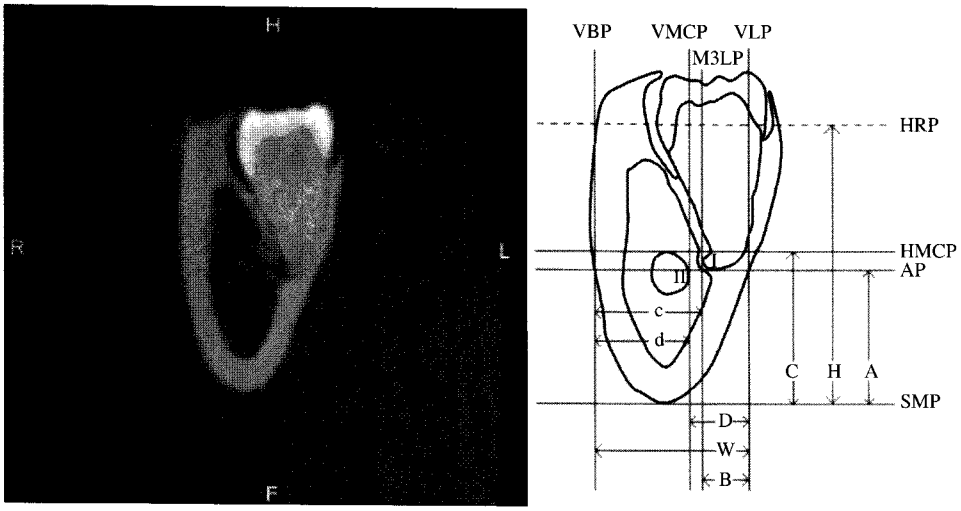


Fig. 2. Reference planes for the positional analysis of the mandibular third molar and the mandibular canal in coronal image.

imaging analysis and multiplanar reconstruction. The slice thickness of the multiplanar reconstruction images was 0.1 mm. The images were observed by LCD monitor (18 inch, A1109N, Atec., Korea) with a 1,280 × 1,024 resolution.

2) Position analysis of the mandibular third molar and the mandibular canal

Impacted mandibular third molars were classified as mesioangular, horizontal, vertical, distoangular according to the angulation of the mandibular third molar in panoramic radiographs. The reference planes were decided as follows in cone-beam computed tomographs (Figs. 1, 2).

Horizontal Reference Plane (HRP): plane connecting the cementoenamel junctions of the mandibular second molar in the sagittal image

Vertical Mandibular Plane (VMP): plane coming in to contact with the lateral side of the mandibular second molar and intersecting the horizontal reference plane at a right angle

Apical Plane (AP): plane passing through the lowest point of the mandibular third molar and intersecting the vertical mandibular plane at a right angle

Horizontal Mandibular Canal Plane (HMCP): plane passing the superior border of the mandibular canal and intersecting the vertical mandibular plane at a right angle

M3 Lateral Plane (M3LP): plane coming in to contact with the lateral side of the apical third of the mandibular third molar and intersecting the horizontal reference plane at a right angle

Vertical Mandibular Canal Plane (VMCP): plane coming in to contact with the mesial side of the mandibular canal intersecting the horizontal reference plane at a right angle

Vertical Lingual Plane (VLP): plane passing the point of intersection of the lingual cortical plate and the horizontal apical plane and intersecting the horizontal reference plane at a right angle

Vertical Buccal Plane (VBP): plane passing the point of intersection of the buccal cortical plate and the horizontal apical plane and intersecting the horizontal reference plane at a right angle

Standard Mandibular Plane (SMP): plane passing the lowest point of the mandible and parallel with the horizontal reference plane

I: the nearest point of the apical third of the mandibular third molar to the mandibular canal

II: the nearest point of the mandibular canal to the apical third of the mandibular third molar

H: A distance from the horizontal reference plane to the horizontal mandibular plane

W: A distance from the vertical lingual plane to the vertical buccal plane

Using these reference planes, the shortest distance was calculated from the lowest point of the mandibular third molar to the highest point of the mandibular canal (a-b). A positive value was obtained when the mandibular canal was positioned inferior to the mandibular third molar. While a negative value was obtained when the mandibular canal was positioned superior to the mandibular third molar. The shortest distance was calculated from the lateral point of the apical third of the mandibular third molar to the mesial point of the mandibular canal (c-d). A positive value was obtained when the mandibular canal was positioned buccally to the mandibular third molar, while a negative value was obtained when the mandibular canal was positioned lingually to the mandibular third molar. According to the angulation of the mandibular third molar, A and B distances were calculated. The ratios of the distances to

Table 2. The distance from the apical third of the mandibular third molar to the mandibular canal (mm)

Distance	Mesioangular	Horizontal	Vertical	Distoangular
Vertical				
Mean±SD	0.03±2.36	0.37±1.45	−1.50±1.63	−1.10±2.41
Buccolingual				
Mean±SD	2.96±3.54	3.38±2.92	1.38±3.37	4.20±2.92

the height of the mandible (H), and to the width of the mandible (W) in order to examine how to change the point I vertically and buccolingually was calculated. Also, C and D distances were calculated, and the ratios of the distances to the H, and W in order to examine how to change the point II were calculated.

3) Statistical analysis

The Statistical Package for Social Science software (SPSS Inc, USA) was used for statistical analysis. ANOVA was also performed to compare the results of all groups to determine whether there was a significant difference in position of the mandibular third molar and the mandibular canal.

Results

1. Distance from the lowest point of the mandibular third molar to the highest point of the mandibular canal (Table 2)

Mean distances were 0.03±2.36 mm in the mesioangular group, 0.37±1.45 mm in the horizontal group, −1.50±1.63 mm in the vertical group, −1.10±2.41 mm in the distoangular group. The lowest point of the mandibular third molar was positioned superiorly to the mandibular canal in the mesioangular and horizontal groups. The lowest point of the mandibular third molar was positioned higher in the horizontal group as compared to the mesioangular group ($P<0.05$). The lowest point of the mandibular third molar was positioned below to the mandibular canal in the distoangular and vertical groups. The lowest point of the mandibular third molar was positioned inferiorly to the mandibular canal in the vertical group, and it was lower than in the distoangular group ($P<0.05$).

2. Distance from the lateral point of the apical third of the mandibular third molar to the mesial point of the mandibular canal (Table 2)

Mean distance was 2.96±3.54 mm in the mesioangular group, 3.69±2.92 mm in the horizontal group, 1.64±3.37 mm in the vertical group, and 4.20±2.92 mm in the distoangular group respectively. There was no significant difference between groups ($P>0.05$).

Table 3. The ratios of the distance from the nearest point (I) of the mandibular third molar to the mandiabular inferior border and to the lingual cortical plate within the mandibular body (%)

Ratio (%)	Mesioangular	Horizontal	Vertical	Distoangular
Vertical				
Mean±SD	47.1±5.92	47.4±6.60	39.0±7.06	41.0±6.53
Buccolingual				
Mean±SD	36.1±12.6	34.4±13.0	46.7±14.7	37.4±12.7

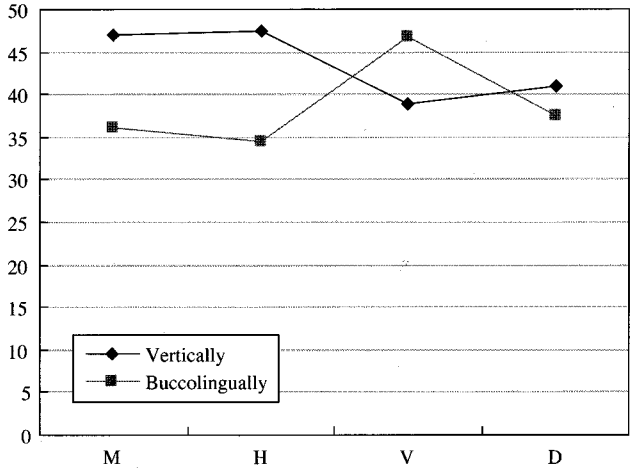


Fig. 3. Ratios of the distances from the nearest point (I) of the mandibular third molar to the mandibular inferior border and to the lingual cortical plate within the mandibular body (%).

3. Position analysis of the nearest point of the mandibular third molar at the apical third to the mandibular inferior border and to the lingual cortical plate (I) (Table 3, Fig. 3)

The ratios of the distances from the nearest point (I) of the mandibular third molar to the mandibular inferior border and to the lingual cortical plate within the mandibular body were 47.1% and 36.1% in the mesioangular group, 47.4% and 34.4% in the horizontal group, 39.0% and 46.7% in the vertical group and 41.0% and 37.4% in the distoangular group. There were significant differences between the mesioangular and the vertical group, and the horizontal and the vertical group in the sagittal images, and between the mesioangular and the vertical group in coronal images ($P<0.05$). The root apex of the mandibular third molar was positioned more buccally in the vertical group than the mesioangular group.

Table 4. The ratios of the distances from the nearest point (II) of the mandibular canal to the mandibular inferior border and to the lingual cortical plate within the mandibular body (%)

Ratio (%)	Mesioangular	Horizontal	Vertical	Distoangular
Vertical				
Mean±SD	46.7±13.4	46.3±12.4	45.5±14.5	45.1±8.18
Buccolingual				
Mean±SD	54.6±6.46	57.2±5.96	54.1±5.43	61.7±7.29

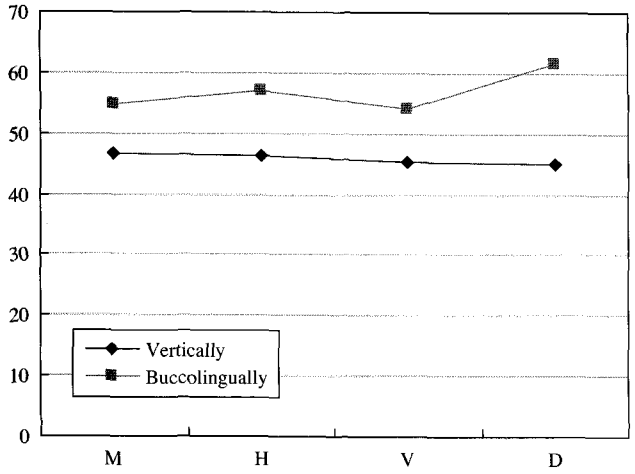


Fig. 4. Ratios of the distances from the nearest point (II) of the mandibular canal to the mandibular inferior border and to the lingual cortical plate within the mandibular body (%)

4. Position analysis of the nearest point (II) of the mandibular canal to the mandibular inferior border and to the lingual cortical plate within the mandibular body (Table 4, Fig. 4)

The ratios of distances from the nearest point (II) of the mandibular canal to the mandibular inferior border and to the lingual cortical plate within the mandibular body were 46.7% and 54.6% in the mesioangular group, 46.3% and 57.2% in the horizontal group, 45.5% and 54.1% in the vertical group, and 45.1% and 61.7% in distoangular group. However, there were no significant differences between groups ($P > 0.05$).

Discussion

Extraction of the mandibular third molar is one of the most common surgical procedures for the oral and maxillofacial region. In addition to pain and swelling, the removal of an impacted third molar may result in dysesthesia of the mandibular nerve.[16,17] Because mandibular nerve damage is caused by injury to the sensory nerve bundle, preoperative radiographic examination is required to diagnose this close relationship between the apices of impacted teeth and the mandibular canal.

In this study, mandibular third molars were classified as mesioangular, horizontal, vertical and distoangular according to the angulation of tooth impaction. There was much to be desired in studies of distance measurements and positional relationship between the mandibular third molar and the mandibular canal. Blaeser et al.[18] reported that the angulation type of the mandibular third molar was not correlated with the damage of the mandibular canal. Kipp and Goldstein et al.[19] reported that the incidence of paresthesia is affected according to the molar angulation.

Miloro and DaBell et al.[20] demonstrated that the distances between the mandibular third molar and the mandibular canal were measured in panoramic radiographs and showed negative values in all mesioangular, horizontal, vertical, distoangular groups. According to the study, the root apex of the mandibular third molar was positioned most inferiorly in the mesioangular group. Cone beam comuted tomography was used to provide useful anatomic diagnostic information of the positional relationship between the mandibular third molar and the mandibular canal, and to measure accurate distance. In this study, the mesioangular group showed the nearest distance between the mandibular third molar and the mandibular canal in sagittal images. The vertical group showed the lowest positioned apical third of the mandibular third molar. The lowest point of the apical third of the mandibular third molar was positioned superiorly to the mandibular canal and showed a positive value in the mesioangular and horizontal groups. The lowest point of the mandibular third molar was positioned most superiorly in the horizontal group and was positioned most inferiorly in the vertical group, and there were significant differences between them. Therefore, the vertical distances between the mandibular third molar and the mandibular canal are different according to the angulation of the mandibular third molar. Panoramic radiographs cannot show buccolingual relationships.

Rajchel et al.[21] reported that the mandibular canal travels most buccally in the mandibular third molar region. In this study, the distances between the mandibular third molar and the mandibular canal were positive values in all groups. The mandibular canals were positioned buccally, and the distoangular group showed the greatest distance between them, but there were no significant differences between groups. This study supported the study of Rajchel et al.

Nortje et al.[22] and Littner[23] reported the positional relation-

ship between the mandibular molars and the mandibular canal. Nortje et al.[23] demonstrated that the apex of the distal root of the mandibular second molar is nearest to the superior border of the mandibular canal, and the traveling angle of the mandibular canal is highly correlated with mandibular angle. In this study, height ratio of the distance from the nearest point (I) of the mandibular third molar to the inferior border of the mandible within the mandibular body was larger in the horizontal, mesioangular, distoangular, vertical group, in order, and there were significant differences between the mesioangular and the vertical group, and the horizontal and the vertical group. Therefore, this study showed that the position of point I within the mandiblar body was different according to the angulation of the mandibular third molar.

The width ratio of the distance from the mandibular third molar to the lingual cortical plate within the mandibular body was larger in the vertical, distoangular, mesioangular, horizontal groups in order, and there was a significant difference between the vertical and mesioangular groups. This result showed that the apex of the mandibular third molar in the vertical group was positioned more buccally than in mesioangular group.

Kaeppler et al.[24] reported the buccolingual relationship between the mandibular third molar and the mandibular canal in tomographs, and stated that the mandibular canal was positioned on the buccal side of the mandibular third molar, and the buccolingual positional relationship was not correlated to the damage of the mandibular nerve. However, according to Maegawa et al.,[25] patients at high risk for postoperative dysesthesia of the mandibular nerve were those who underwent extraction of the mandibular third molar when there was a disappearance of cortication around the mandibular canal and when the mandibular canal was located lingual to the root and between roots in computed tomographs. In this study, 69 of 89 (77%) mandibular canals were positioned buccally to the mandibular third molar. Although the incidence of damage to the mandibular nerve and paresthesia were not investigated, the more lingually positioned group of the mandibular canal was mesioangular (25.0%), vertical (22.2%), horizontal (15.2%), distoangular (10.0%) group in order. It is necessary for additional study to be whether the more the mandibular canal is positioned lingually, the more the mandibular canal is damaged.

The height ratio of the distance from the nearest point (II) of the mandibular canal to the apical third of the mandibular third molar within the mandibular body was larger in the mesioangular, horizontal, vertical, and distoangular groups in order, but there were no significant differences between groups. The ratio of the distance from the nearest point (II) of the mandibular canal to the lingual cortical plate within the mandibular body was larger in distoangular, horizontal, mesioangular, and vertical groups in order, but there were no significant differences between groups.

Although there have been studies on the positional relationship of the mandibular third molar and the mandibular canal using conventional radiographs and computed tomographs, the studies on the distance measurements and positional relationship vertically and buccolingually between the mandibular third molar and the mandibular canal are rare. The results of this study showed the vertical and buccolingual distances and the height and width ratios according to the position of the mandibular third molar and the mandibular canal within the mandibular body. However, the study on the damage of the mandibular canal according to the positional relationship of the mandibular third molar and the mandibular canal is still needed.

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