Evaluation of Impacted Mandibular Third Molar Position in Relation to Mandibular Canal on Panoramic Radiography compared to Cone-Beam Computed Tomography

Saptadi A[1], Lilies DS[2]*, Menik P[3], Benny S. Latief[2]

1. Postgraduate Student of Oral and Maxillofacial Surgery Department, Universitas Indonesia.
2. Department of Oral and Maxillofacial Surgery Department, Universitas Indonesia.
3. Department of Dental Radiology, Universitas Indonesia.

Abstract

The serious complications associated with odontectomies include inferior alveolar nerve injury. The position of impacted mandibular third molars, against the mandibular canal must be accurately determined by radiological examination including two dimensional (panoramic radiograph) and three dimensional (CBCT Scans). We evaluated the positions of impacted mandibular third molars proximal to mandibular canal on a panoramic radiograph based on CBCT scan. This study used descriptive analysis of panoramic radiograph and DICOM file CBCT Scans.

Subjects meeting inclusion criteria were recruited from several healthcare facilities in Jakarta August 2017 until December 2017. We used a computer equipped with Macinthos or Windows operating system and Planmeca Romexis ® Imaging Software Viewer. Data were analyzed using SPSS version 22 and Chi-Square tests. Our review of 108 patients produced 177 teeth samples and 48 patients data resultant 61 teeth samples met inclusion criteria. The most common positions we observed on panoramic radiography was increasing radiolucency. On CBCT scans, the inferior position was the most commonly observed position. There was a statisticaly significant relationship between panoramic radiography and category of lingual-buccal-inferior positioning on CBCT scan.

Our result could be used to evaluate the position of mandibular third molars against the mandibular canal to help reduce risk of inferior alveolar nerve injury during odontectomy.

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Introduction

Management of impacted mandibular third molars, known as odontectomy, is the most commonly performed procedure in the field of oral and maxillofacial surgery. The odontectomy procedure itself may cause complications such as infections, mandibular fractures, *dry sockets,* and inferior alveolar nerve injures.[1] Anderson et al. stated that there are several factors that influence the occurence of inferior alveolar nerve injuries during odontectomy. These include the patient's age, medical condition, the patient's medical history, degree impaction and angulation, and the relationship between the third molar and anatomical structures like the inferior alveolar nerve. The precise position of the impacted mandibular canal should be known when preparing for odontectomy. This information is also important how difficult the odontectomy, will be and reducing the risk of inferior alveolar nerve injury.

In some cases, panoramic radiographs are sufficiently accurate for preoperative assessment of impacted mandibular third molars. Panoramic radiography is a preferred method for several reasons, including the ability to see the entire mandible, maxilla and supporting tissue in one film. Additionally, the technique is simple, uses lower radiation doses, and maximizes patients' comfort. Further, panoramic radiography can be used to quickly image patients who are not able to open their mouths. One disadvantages of two-dimensional panoramic radiography is its inability to provide information in three dimensions. Additionally, panoramic radiographs carry high distortion risk that can make it is difficult to detect multiple roots[4],

Corresponding author:
Lilies Dwi Sulistyani
Department of Oral and Maxillofacial Surgery,
Faculty of Dentistry, Universitas Indonesia,
Jakarta, Indonesia.
E-mail: liliesdwi_s@yahoo.co.id

measure the height of the alveolar bone[5], or determine the position of the inferior alveolar nerve[6].

Currently, cone beam computed tomography (CBCT) scan is one of the diagnostic tools for use on the maxillofacial region. CBCT can depict objects in three dimensions and is useful for dentomaxillofacial imaging because it uses low radiation doses with high resolution and affords dentists easy access, compared to Computed Tomography (CT) scans. However, CBCT scans have a number of disadvantages, including low soft-tissue contrast resolution. CBCT is also higher cost and therefore not accessible to all hospitals in Indonesia. Considering the lack of CBCT scan devices in Indonesia, we evaluated the position of impacted third molar which are located near the mandibular canal, in panoramic radiographs based on CBCT scan. We hypothesized that this method could help estimate the three-dimensional position of mandibular canal from the panoramic radiograph.

Materials and methods

This was a descriptive analytic study that used secondary data in the form of panoramic radiographs and CBCT scans from the Bali Dental Clinic, and Smile Work Dental Care Jakarta. We examined males and females, age 20 – 50 years, with impacted mandibular third molars, using panoramic radiographs and CBCT scans. We assessed the proximity of the impacted mandibular third molars and mandibular canal. Exclusion criteria included pathological disorder affecting the impacted mandibular third molars on panoramic radiography and images where the inferior alveolar nerve was unclear on panoramic radiograph because distortion and shadow on CBCT scans.

This study was conducted at Faculty of Dentistry, University of Indonesia, from August 2017 to December 2017 and was approved by the Research Ethics Committee. Analyses were performed with a computer with Macintosh or Windows operating system equipped with the *Planmeca Romexis® Imaging Software Viewer* and SPSS version 22. We used panoramic radiograph DICOM data volume files from several health facilities with panoramic radiography devices and *Planmeca ProMax 3D® Classic* to obtain categorical data. Data analyses were descriptive, using SPSS version 22 and Chi-Square tests.

Results

This study was conducted at Bali Dental Clinic and Smile Work Dental Care Jakarta in August 2017–December 2017. From 177 samples of impacted mandibular third molars that were examined using panoramic radiography and CBCT scans, we obtained 61 dental samples, proximal to the mandibular canals, from 48 patients. All data were interpreted by three readers, and each reading was conducted twice to calculate inter-rater and intra-rater reliability. On the second reading, 25 % of selected samples were randomized.

To test the objectivity of the position of impacted mandibular third molars to mandibular canals, an intra-reader and inter-reader readability test was performed using Cohen's Kappa coefficients. Based on the results of the Cohen's Kappa test, the whole three readings of both panoramic radiograph and CBCT scans showed good (0.61–0.80) and very good (0.81–1.00) data conformity.

Table 1 shows examinations of 61 impacted mandibular third molar using panoramic radiography. The most common findings were increased radiolucency (42.6%) and were not found the diversion of mandibular canal category.

Position category based on panoramic radiograph	n	%
Superimposed	13	21.3%
Increased radiolucency	**26**	**42.6%**
Interruption of radiopaque margin]0	15	24.6%
Diversion of the mandibular canal	0	0 %
Narrowing of the mandibular canal	7	11.5%
Total	61	100%

Table 1. Frequency Distribution of Impacted Mandibular Third Molars Position to Mandibular Canal Based on Panoramic Radiograph.

Position category	Contact/Non-contact		Total
	Contact	Non-contact	
Lingual	8 (88.9%)	1 (11.1%)	9 (100%)
Buccal	11(68.8%)	5 (31.2 %)	16 (100%)
Interradicular	0 (0%)	0 (0%)	0 (0%)
Inferior	23 (63.9%)	13 (36.1%)	**36** (100%)
Total	42 (68.9%)	19 (31.1%)	61 (100%)

Table 2. Distribution of Impacted Mandibular Third Molars Position to Mandibular Canal based on CBCT Scan.

Additionally, the distribution of impacted mandibular third molar position to mandibular canal based on CBCT scan can be seen in table 2.

Table 3 displays the impacted mandibular third molars on panoramic examination, the superimposition category was the most common in the buccal contact position (46.2%). Increased radiolucency category (34.7%), interruption radiopaque border category (73.3%), narrowing of mandibular canal category (28.8%), the three most found in the inferior position of contact. There were no criteria for diversion of the mandibular canal on panoramic and interradicular radiographs examination on CBCT scan.

Category Based on Panoramic Radiograph	Category Based on CBCT Scan								Total
	Lingual		Buccal		Interradicular		Inferior		
	Contact	Non-Contact	Contact	Non-Contact	Contact	Non-Contact	Contact	Non Contact	
Superimposition	1 (7.7%)	1 (7.7%)	**6 (46.2%)**	1 (7.7%)	0 (0%)	0 (0%)	1 (7.7%)	3 (23.1%)	
Increasing of Radiolucency	4 (15.4%)	0 (0%)	2 (7.7)	3 (11.5%)	0 (0%)	0 (0%)	**9 (34.7%)**	8 (30.7%)	
Interruption of the Radiopaque Border	1 (6.7%)	0 (0%)	2 (13.3%)	1 (6.7%)	0 (0%)	0 (0%)	**11 (73.3%)**	0(0%)	
Diversion of the Mandibular Canal	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	
Narrowing of the Mandibular Canal	2 (28.6%)	0 (0%)	1 (14.3%)	0 (0%)	0 (0%)	0 (0%)	**2 (28.6%)**	2(28.6%)	
	8 (13.1%)	1 (1.6%)	11 (18%)	4 (6.5%)	0	0	**23 (37.7%)**	13(21.3%)	

Table 3. Distribution of Impacted Mandibular Third Molar Position on the Mandibular Canal Based on Panoramic Radiograph and CBCT Scan.

To see the difference proportion between Panoramic Radiograph and CBCT Scan categories, we used Chi-Square test calculator with p value listed in Table 4 and 5. Table 4 shows that there is no significant difference (p> 0.05) between the panoramic radiographic examination category and the contact - non contact position on CBCT scan.

Panoramic Radiographic	Contact	Non-Contact	P Value
Superimposition	8(61.5%)	5(38.5%)	0.109
Increased radiolucency	15(57.7%)	11(42.3%)	
	14(93.3%)	1(6.7%)	
Interuption of radiopaque margin			
Narrowing of mandibular canal	5(71.4%)	2(38.6%)	
Total	42(68.9%)	19(31.1%)	

Table 4. Difference in Proportion Between Panoramic Radiographic Examination Contact and Non-Contact Category on CBCT Scan.

Table 5 shows that there is a statistically significant difference in the panoramic radiograph category and lingual-buccal-inferior category on CBCT. On the superimposition position category, the largest proportion was in the buccal CBCT scan position (63.6%). For increased radiolucency, interruption of the radiopaque border, and narrowing of the mandibular categories on panoramic radiography, the largest proportion was in the inferior CBCT scan position. The superimposition position had the largest proportion in the buccal position of the CBCT Scan results (63.6%), whereas the increased radiolucency (63.8%), interruption of radiopaque border (73.3%) and narrowing of the mandibular canal (57.14%) on panoramic radiograph the largest proportion was in position inferior from the results of CBCT Scan

Panoramic Radiograph	Lingual	Buccal	Inferior	P value
Superimposition	2 (18.8 %)	**7 (63.6%)**	4 (36.36 %)	0.000
Increasing of Radiolucency	4 (15.38 %)	5 (19.23%)	**17 (65.38%)**	
Interruption of the Radiopaque border	1 (6.7 %)	3 (20 %)	**11 (73.33%)**	
Narrowing of the Mandibular Canal	2 (28.57 %)	1 (14.3 %)	**4 (57.14%)**	

Table 5. Difference of Proportion between Panoramic Radiograph Examination and Lingual-Buccal-Inferior Category on CBCT Scan.

Discussion

Inferior alveolar nerve injury is a serious complication resulting from odontectomy of the mandibular third molars. Factors affecting the occurrence of inferior alveolar nerve injury include the degree of impaction, impaction gear angulation, and the interaction of the mandibular implant third molar with the nearest anatomical structure of the mandibular canal.[4] It is therefore important to know the precise distance between the mandibular third molars with the mandibular canal. This process can be used in prior to selection of an odontectomy technique. Panoramic radiography is used to assess the relationship between mandibular third molars and the mandibular canal. However, Panoramic Radiographs cannot provide three-dimensional information. In this study, we evaluated the position of mandibular implanted third molars and the mandibular canal on panoramic radiography, based on CBCT scans.

We used a descriptive analytic method and collected secondary data in the form of panoramic radiography and CBCT scans. Data were analyzed by three readers, and two readings were used to calculate intra-reader and inter-reader reliability using Cohen's Kappa test. On the basis of the results of the test, the best Kappa values were obtained from Reader 1 and all readings from the three readers showed good (0.61–0.80) and very good (0.81–1.00) data conformity.

According to Monaco et al., [10] the position of impacted mandibular third molars relative to the mandibular canal, based on panoramic radiograph, is indicated by superimposition, increased radiolucency, radiopaque boundary interruption, diversion of the mandibular canal, and narrowing of the mandibular canal.[6] In this study, the most widely found position category was increased radiolucency, equal to 42.6%. This is agreement with Monaco et al. They found 50.68% among 73 tooth samples.[10] Kursun et al. examined 180 samples and found that the highest result was interruption of the radiopaque border, with 28.3%.[18] Study conducted by Tantanapornkul et al. in Thailand included 178 samples. Here, the highest result was interruption of the radiopaque border, with 69.14%.[26] Study conducted by Neves et al., which included 142 samples, found interruption of the radiopaque border in 20.4%.[27] Ethnicity-

related variables may explain the different results among these research studies. The position that found on this study or the other studies before are the indicator of risk increasing of the alveolaris nerve trauma on odontectomy procedure. In 2012, Never said that there are various marks on panoramic radiography related to trauma of alveorais inferior nerve, specifically, increased radiolucency and radipaque border interruption.[27] according to Szalma 2011, increased radiolucency is an important sign that can increase the risk of nerve trauma by 50% or more.[12] Consequently, CT scans are recommended to obtain more accurate result. In 2017, Tantanapornkul stated that there was increased radiolucency on panoramic radiography that showed teeth exerting pressure on the mandibular canal, depletion of the cortical plate on the lingual side, or cortical plate perforations. This will increase the risk of occurrence of inferior alveolar nerve trauma during odontectomy.

Three-dimensional imaging produced by CBCT scan gave four classifications: lingual, interradicular, buccal, and inferior.[19] As illustrated in Table 5.5, the position of the mandibular third molar, imposed on the mandibular canal and based on the three-dimensional CBCT scan, was the inferior position of 42 (86.1%). This is in line with research conducted by Wang et al. who found inferior position results of 78.8%. Tantanapornkul et al. found the inferior position results on 45;[29] Monaco et al. examined 73 samples and found inferior position results on 51%.[10]

On the basis of Table 4, about 42 (68.9%) impacted mandibular third molars were located on the contact position. Among 42 mandibular third molars located in the inferior position, there were 23 (63.91%) located in the contact position. There are therefore no significant differences between panoramic radiography examination and CBCT scans.

However, impacted mandibular third molars with contact position on CBCT scan examination which shows no cortical bone between the inferior alveolar nerve and impacted mandibular third molars, it can be expected that the inferior alveolar nerve will experience direct suppression during odontectomy process, which may potentially increase the risk of inferior alveolar nerve injury.

We found a significant difference between the two groups. In summary, if a superimposed position was found on panoramic radiography, then 63.6% were in the buccal position. If increasing radiolucency was found, then 65.38% were in the inferior position. If an interrupted radiopaque border position was found, 73.33% were in the inferior position. If the channel narrowing position was found, then 57.14% were in the inferior position.

The results of the examination based on Panoramic Radiograph on the position of increased radiolucency most commonly found in the inferior position based on CBCT Scan. Embryologically, the growth of the mandibular canal coincides with the growth of the mandible. Mandibular third molar growth occurs when the mandibular canal is formed; thus, if there is contact between the mandibular canal and the root of the impacted mandibular third molars, there is likely to be an increase in radiolucency and more likely inferior to the CBCT scan.[4]

This study had a limited number of samples (61 samples) because we only included radiographic images that showed impacted mandibular third molars proximal to the mandibular canal. Additionally, CBCT scan use is primarily limited to examination of impacted mandibular third molars, which can usually be examined using pre-operative panoramic radiography. This study makes a small contribution toward anthropometric research that can be used for clinical applications. Determining the positions of impacted mandibular third molars based on panoramic radiography and CBCT can be a useful way to guide odontectomy and reduce the risks of complications, particularly inferior alveolar nerve injuries.

Conclusions

In conclusion, the most category position of impacted mandibular third molars on the mandibular canal based on panoramic radiograph is an increased radiolucency (42.6%) and based on CBCT Scan is inferior (59%). Moreover, the risk of inferior alveolar nerve injury can be estimated from panoramic radiography examinations and CBCT scans. If there is an increased radiolucency category on Panoramic Radiographic examination, it is found mostly in the inferior position in CBCT Scan

This research can be used as a reference for evaluating the position of impacted

mandibular third molars relative to the mandibular canal, for estimating the likelihood of complications during odontectomy procedures.

Additional samples are needed in order to validate these data. There is required Samples from various panoramic devices and CBCT scans which can be read by one type of reader device to get more data.

Declaration of Interest

The authors report no conflict of interest.

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