ECRONICON OPEN ACCESS

EC DENTAL SCIENCE
Research Article

The Validity of the Panoramic Radiograph in Evaluating the Relationship between Mandibular Canal and Impacted Third Molars in Comparison with Cone Beam CT-Scan

Akash Kadam[1], Mahesh Chavan[2] and Vikram Khare[3]*

[1]Dr. D. Y. Patil Vidyapeeth, Pune, Maharashtra, India

[2]Reader, Department of oral medicine and radiology, Dr. D Y Patil Vidyapeeth, Pune

[3]Head of oral medicine and radiology department , Dr. D Y Patil Vidyapeeth, Pune

***Corresponding Author:** Akash Kadam, Dr. D. Y. Patil Vidyapeeth, Pune, Maharashtra, India.

Received: December 14, 2017; **Published:** February 27, 2018

Abstract

Introduction: Incidence of inferior alveolar nerve damage during third molar extraction is 3.3% - 13%. Panoramic radiography is primary screening method for the inferior alveolar nerve and third molar root proximity. Markers on Panoramic radiography may suggest direct contact between IAN and third molar root as compared on CBCT. This paper studies validity for each marker. Based on the validity of these marker use of advance imaging modality such as CBCT is predicted.

Aim: To validate panoramic radiography in evaluating the relationship between mandibular canal and impacted third molars in comparison with Cone Beam CT-scan (CBCT).

Objectives: To assess presence or absence of direct contact between the mandibular third molar roots and the mandibular canal on panoramic radiographs on the basis of four radiographic markers compared to CBCT. To assess the predictive value of four radiographic markers of Panoramic radiographs on the basis of CBCT scan.

Materials and Method: Present study is descriptive analytical in vivo study done on patients coming to OPD of Oral Medicine and Radiology Department of Dr. D.Y. Patil Dental College and Hospital for mandibular third molar evaluation. Study was conducted at Dr. D.Y. Patil Dental College and Hospital, Pimpri, Pune. The study was conducted with a sample size of 34 mandibular third molars. It consists of 21 female and 13 males of Maharashtrian population in the age group between 19 and 60 years. Panoramic radiograph was taken first and evaluated. Four radiographic marker were studied. Those Panoramic radiograph showed presence of one of the marker were scanned on CBCT. CBCT scans were studied for the markers confirming contact with IAN.

Results: Table showing sensitivity, specificity, PPV, and NPV of OPG markers.

	Marker	Sensitivity	Specificity	PPV	NPV
1	Darkening of roots	16%	80%	80%	27%
2	Interruption of canal wall	24%	88%	85%	29%
3	Mandibular canal diversion	5%	40%	10%	24%
4	Dilacerations of roots	62%	30%	68%	25%

Conclusion: Panoramic radiograph should be primary screening radiographic modality for detecting the proximity between mandibular third molar and mandibular canal. Root dilacerations is the most sensitive marker and interruption in mandibular canal wall is most specific marker. Presence of this markers shows close proximity of the mandibular canal to the mandibular nerve. Presence of these markers and dilemma in predicting the proximity between mandibular third molar and mandibular canal necessitate the use of advance imaging modality such as CBCT.

Keywords: *Panoramic Radiograph; Mandibular Canal; Third Molars; Cone Beam CT-Scan*

Introduction

Human beings are always the part of evolutionary process. As the part of evolutionary process even the face and jaws have changed. Previously the jaws were like a snout that means protruded to accommodate more number of teeth. As human became more civilized there was drastic change in dietary habits. Humans started cooking food after invention of fire. Comparatively humans have started eating soft cooked food as against uncooked raw food. So there was de-crease in number of teeth. Though we consider 32 teeth presently but very less population have them functional. In dental treatment planning only 28 teeth are considered excluding third molars. Third molars rarely used in the treatment planning if it fulfill other criteria. Third molars erupt in the age between 18 - 25 years, the age were normally human gets wisdom, so third molars are also called wisdom teeth. Growth of jaws is almost ceased before its eruptions. Also jaw size can be genetically acquired from one parent and morphology of the dentition from another. This discrepancy leads to very less space for mandibular third molar to erupt. Decrease in size of jaws as evolutionary process, lesser need of third molars in mastication as the change in dietary habits, and time of eruption of third molars cause anomalous behavior of third molars. These are the main factors for third molars to impact. And so the commonest treatment for impacted third molars is its extraction.

Dental Impaction is defined as failure of eruption of tooth in the oral cavity in the normal eruption time [1]. It is a pathological condition [1]. The most commonly impacted tooth is mandibular third molar followed by maxillary canine [2]. The removal of impacted third is the commonest procedure carried out by dental surgeons [3]. Appropriate management of impacted third molars require precise diagnosis regarding location of impacted teeth and its relationship with surrounding morphological structures [1]. There is inferior alveolar nerve canal in proximity to third molars and impaction of these molars further increases the proximity. Transalveolar extraction of mandibular third molar may result in damage to inferior alveolar neurovascular bundle. Neurological damage to the nerve occurs due to improper diagnosis of tooth with surrounding structure or in-appropriate surgical method employed.

The occurrence of these nerve damage ranges from0.2 to 1% for a permanent injury and from 3.3% to 13%for temporary injury [2]. This incidence of damage increases to 30% when nerve is diagnosed as close to roots of mandibular third molar radiographically [2]. This necessitates the appropriate preoperative diagnosis of mandibular third molar and mandibular canal with the help of radiographs, which will also reduce the rate of incidence of nerve damage.

Maxillofacial imaging modalities are essential diagnostic tool to avoid injury to inferior alveolar neurovascular bundle during transalveolar extraction of impacted mandibular third molar. Panoramic radiography is the most common radiological technique used to assess the proximity be-tween mandibular third molar and mandibular canal. This conventional 2 dimensional radio-graphic modality is sufficient for the diagnosis of routine cases of third molar impaction. Additional information from advance radiographic modalities may be required when the root tips of third molar shows close proximity to inferior alveolar nerve canal. Panoramic radiography has the drawbacks like superimposition, distortion and magnification as it gives 2 dimensional image of three dimensional object [1]. Panoramic radiology cannot identify the proximity, if mandibular canal fails to show the cortication. Identifying the location of nerve buccal or lingual to third molar roots or in between the roots is not possible on Panoramic radiograph [2]. Many clinical studies have mentioned the radiographic markers detected in panoramic radiographs, which may suggest the presence of a proximity between the mandibular canal and mandibular third molars [4]. These radiographic signs include darkening of the root, interruption of mandibular canal wall, mandibular canal diversion, root dilacerations. However, opinions vary regarding the frequencies of the above-mentioned signs for predicting exposure of the inferior alveolar nerve or a clinical complication such as paresthesia as a result of mandibular third molar extraction [4].

If the radiological markers on a panoramic radiograph are suggestive of close relationship be-tween the impacted third molar and the mandibular canal, additional evaluation by advance 3 dimensional imaging modalities is recommended for further clarification.

CT scan are more useful than panoramic radiography for evaluation of the exact location of the mandibular canal in relation to the third molar [5]. However, CT scan has also some disadvantages including higher doses of radiation and economic costs and more difficult access to modality [5].

A new type of computed tomography scan known as CBCT is presented to maxillofacial imaging after its first use in cardiology. CBCT uses cone shaped beam of x-rays rather than the fan shaped beam used in normal CT scan. CBCT offers the same details and reconstruction with the help of software as normal CT scan but at a low cost, low radiation dose with less equipment and infrastructural requirements [5].

CBCT is a specialized technique and is not available everywhere so there is need to study the predictive value for the four radiographic markers (darkening of the root, interruption of mandibular canal wall, mandibular canal diversion, root dilacerations) on Panoramic radiograph as evidenced on CBCT. If panoramic radiography warns us about the proximity of mandibular nerve to mandibular third molar by showing markers, CBCT may not be necessary and the patient can be warned against high probability of nerve damage without CBCT. The surgeon may suggest CBCT based on his clinical judgment in cases where the predicative value of a particular marker is high in panoramic radiograph [5].

Aims and Objectives

Aim: To validate panoramic radiography in evaluating the relationship between mandibular canal and impacted third molars in comparison with Cone Beam CT-scan (CBCT).

Objectives

1. To assess presence or absence of direct contact between the mandibular third molar roots and the mandibular canal on panoramic radiographs on the basis of four radiographic markers.
2. To assess presence or absence of direct contact between the mandibular third molar roots and the mandibular canal on CBCT scan.
3. To assess the predictive value of four radiographic markers of Panoramic radiographs on the basis of CBCT scan.

Review of Literature

Imaging is an important diagnostic adjunct to the clinical assessment of the dental patient. The introduction of panoramic radiography in the 1960s and its widespread adoption throughout the 1970s and 1980s heralded major progress in dental radiology, providing clinicians with a single comprehensive image of jaws and maxillofacial structures. However, intraoral and extra-oral procedures, used individually or in combination, suffer from the same inherent limitations of all planar two-dimensional (2D) projections: magnification, distortion, superimposition, and misrepresentation of structures. Numerous efforts have been made toward three-dimensional (3D) radio-graphic imaging (e.g. stereoscopy, tuned aperture CT) and although CT has been available, its application in dentistry has been limited because of cost, access, and dose considerations. The introduction of cone-beam computed tomography (CBCT) specifically dedicated to imaging the maxillofacial region heralds a true paradigm shift from 2D to 3D approach to data acquisition and image reconstruction.

Historical Background

The development of panoramic radiography in the 1950s and its commercial introduction in 1965 led to the widespread adoption and use of the technology. Although widely used, these images have the same inherent limitations as other 2D projections, namely, magnification, superimposition of anatomical and/or pathological entities, and misrepresentation of structures. However panoramic radiography is efficient at providing an overview of oral and maxillofacial hard tis-sues, including teeth, and may reveal associated pathologies of the jaws.

The original scanner, by EMI, was designed to make cross sectional images of the brain. It was made up of three basic components: a scanner gantry, a table for the patient, and a computer to perform the calculations. The scanner gantry was doughnut shaped device that contained a movable x-ray tube focused on a pair of parallel scintillation crystal x-ray detectors. The mathematical process, back projection that was used on the first scanners was described at the beginning of the century.

Modern, state-of-the-art CT scanners function much the same as the original EMI scanner. The patient is not held in a water bath but still must be restrained in a comfortable head holder to pre-vent even the slightest motion. The pair of detectors has been replaced by sophisticated array of detectors capable of making large numbers of simultaneous measurements of x-ray absorption. Spiral CT scanners can produce up to 30 slices, each 1.0 mm in thickness, per minute. Modern CT images are much more detailed.

To overcome some of the above limitations cone beam computed tomography (CBCT) for the jaws was developed in the 1990s and is gaining widespread acceptance in dentistry, especially in the last 5 years.

The introduction of cone-beam computed tomography (CBCT) specifically dedicated to imaging the maxillofacial region heralds a true paradigm shift from a 2D to a 3D approach to data acquisition and image reconstruction. Interest in CBCT from all fields of dentistry is unprecedented be-cause it has created a revolution in maxillofacial imaging, facilitating the transition of dental diagnosis from 2D to 3D images and expanding the role of imaging from diagnosis to image guidance of operative and surgical procedures by way of third-party applications software.

During the early development of CBCT, the technology was being advanced primarily for the dental office. Subsequently, many of the earlier units were modified to include designs that more readily fit within dental offices and clinics.

The integration of CBCT imaging in dentistry has in some ways paralleled the transition of panoramic imaging x-ray machines into dental offices. Early panoramic units were mainly sit-down, but there was also a lay-down unit. Several other sit-down machines were manufactured, but eventually units were made whereby the patient could stand upright for the panoramic exposure. Upright machines became preferable, as it is more convenient and takes less time to transfer patients into and out of these stand-up panoramic units. The physical size and shape of CBCT units has paralleled this panoramic pathway.

Appropriate assessment of mandibular third molar and its relationship with mandibular canal needs three dimensional imaging modality but in literature several markers on Panoramic radio-graphs are mentioned. These markers help us to assess the risk of damage to mandibular nerve.

Singh., *et al*. [1], in 2013 did a study on 20 subjects aiming to assess the reliability of high risk injury signs to inferior alveolar nerve on Panoramic radiograph. Darkening of roots, superimposition of roots on mandibular canal were significantly associated with presence of corticalisation of mandibular canal (P value < 0.05) and interruption of white line was significantly associated with absence of corticalisation of mandibular canal (P value < 0.05). Darkening of roots was significantly associated with cortical plate perforation (P value < 0.05). No statistically significant association was observed for the other panoramic radiographic findings, either individually or in association (P value > 0.05). Darkening of roots and interruption of white line observed on panoramic radio-graphs were effective in determining the risk relationship between the tooth roots and mandibular canal.

Mela., *et al*. [2] in 2014 did a study to evaluate the role of cone-beam computed tomography (CBCT) in the assessment of the relation between the mandibular canal and impacted third molars. He concluded panoramic radiography was an effective method for preoperative assessment of mandibular third molars Interruption of white line observed on panoramic radiographs, as isolated finding or in association with root darkening, are effective in determining the risk relation-ship between the tooth roots and the mandibular canal, requiring 3D evaluation of the case.

Shujaat., *et al*. [3], concluded horizontally angulated impactions were most common in the mandible, and significantly associated with lingual and inferior positioning of the ID canal (76.2%) in his study.

Dalili Z., *et al*. [4], in his study mentioned the lingual course of the canal was the most frequently detected course in all panoramic findings. Contact of the tooth with the canal was observed in all cases in which panoramic signs of deviation of the canal and darkening of the

roots were found. The frequency of observing the narrowing of the canal in CBCT as compared to seeing the presence or the absence of canal narrowing in panoramic radiographs was significantly different (P = 0.01). CBCT provides more precise diagnostic information to determine the relationship of impacted third molars to the canal. Deviation of the canal and darkening of the roots in panoramic view can be highly valuable to predict the risk of nerve injury.

Ebrahimifard T., *et al*. [5], did a study titled, the validity of the panoramic radiography in evaluating the topographic relationship between mandibular canal and impacted third molars in comparison with cone beam CT-scan. In this descriptive-analytical study, 80 mandibular third molars were extracted from 48 patients. He concluded that presence or absence of radiological sign in Panoramic radiography will not properly predict the existence of a close relationship with third molar and it is suggested that in case of tooth canal overlapping either as a superimposition or as other aforesaid markers, the patient should be referred for CBCT assessment regarding the additional and useful information provided by CBCT.

Pathak S., *et al*. [6], designed a study containing 100 impacted third molars need to be removed. Presence of radiographic findings orthopantomogram were noted and analyzed, to find a relationship with occurrence of post-operative inferior alveolar nerve paresthesia. Out of seven, four radiological findings that are grooving of roots, hooked roots, bifid roots and obliteration of white line are significantly related to post-operative paresthesia while bending of canal, narrow canal and darkening of tooth roots over the canal are not significantly associated with post-operative morbidity of facial nerve.

Shahidi S., *et al*. [7], did comparison of panoramic radiography with cone beam CT in predicting the relationship of the mandibular third molar roots to the alveolar canal. CBCT images of 132 impacted mandibular third molars were evaluated to determine the association of the root to the canal. The CBCT findings were compared with the corresponding panoramic images. Logistic regression analysis was used to define the diagnostic criteria of the panoramic images. Among the panoramic signs, loss of the cortical line was the most frequent radiographic sign predicting association (sensitivity: 79.31). Contact of the tooth with the canal was observed in all cases in which the loss of cortical line of the canal or darkening of the roots was found on the panoramic radiographs. Darkening of the roots and loss of the cortical line on panoramic radiographs might be highly suggestive of the risk of nerve injury.

Carrio C., *et al*. [8], studied radiographic signs associated with inferior alveolar nerve damage following lower third molar extraction. The aim of study was to carry out a literature review of pre-operative radiographic signs in orthopantomography (OPG) and computed tomography (CT) related with the risk of inferior alveolar nerve damage during the surgical extraction of lower third molar (LTM). He searched on PubMed for literature published between the years 2000 and 2009. In the reviewed literature, radiographic signs in the OPG that indicate a relationship between the LTM and the inferior alveolar canal are considered a risk factor for nerve damage. These signs were darkening and deflection of the root, and diversion and interruption in the white line of the canal. In the majority of these studies, the routine use of CT is not justified, and is only recommended when radiographic signs appear in the OPG that demonstrate a direct anatomical relationship between the LTM and the canal. In the CT, the absence of cortical bone in the canal implies a contact between the root of the LTM and the canal, and is related with the presence of some radiographic signs in the OPG. Some studies demonstrate that despite the absence of cortical bone, the risk of lesion or exposure of the nerve during the extraction of LTM was low.

Sinha P., *et al*. [9], did assessment of proximity of impacted mandibular third molar roots to the mandibular canal using intra oral periapical radiography and cone-beam computerized tomography. It was a comparative study. This study showed the poor reliability of radiographic signs of IOPAR predicting the proximity of mandibular third molar root with mandibular canal related to CBCT finding. This creates the controversy and questions regarding the radiographic signs of IOPAR reliability with CBCT findings that was found far more precise and accurate as per for future prospects.

Yabroudi F., *et al*. [10], concluded Cone Beam Computed Tomography (CBCT) provides useful in-formation regarding the 3-dimensional relationship between the mandibular third molar and the mandibular canal. Thus it can be used for risk assessment and planning of the surgical procedure.

Peker I., *et al*. [11], studied panoramic radiography and cone-beam computed tomography findings in preoperative examination of impacted mandibular third molars (IMTM). This retrospective study included 298 teeth in 191 individuals. The relationship between the inferior alveolar canal (IAC) and the IMTM (buccal, lingual, inter-radicular or inferior), the position of the IMTM with respect to the IAC (contact, no contact), the morphologic shape of the mandible in the IMTM region (round, lingual extended, lingual concave), the type of IMTM (vertical, horizontal or angular) and the number of roots of the IMTM were evaluated on CBCT images. He concluded panoramic radiography is inadequate, whereas CBCT is useful to detect multiple roots of IMTM. When darkening of the roots and interruption of the white line are observed on panoramic images, there is increased likelihood of contact between the IMTM and the IAC. CBCT is required in these cases.

Tantanapornkul W., *et al*. [12] did a comparative study of cone-beam computed tomography and conventional panoramic radiography in assessing the topographic relationship between the mandibular canal and impacted third molars. He believed that darkening of roots, a radiographic marker indicated thinning or perforation of lingual cortical plate. He also found that mandibular canal is mostly situated lingual to the third molar in the sample he studied.

Monaco G., *et al*. [13], did a study on reliability of panoramic radiography in evaluating the topo-graphic relationship between the mandibular canal and impacted third molars. His studied concluded that mandibular canal is placed buccally to third molar. And Panoramic radiography is a reliable tool in studying the topographic relationship of mandibular third molar.

Blaeser BF., *et al*. [14] in his study of panoramic radiographic risk factors for inferior alveolar nerve injury after third molar extraction confirms previous analyses showing that panoramic findings of diversion of the inferior alveolar canal, darkening of the third molar root, and interruption of the cortical white line are statistically associated with IAN injury. Based on the estimated predictive values, the absence of positive radiographic findings was associated with a minimal risk of nerve injury, whereas, the presence of one or more of these findings was associated with an increased risk for nerve injury.

Park W., *et al*. [15] in his article titled, cortical integrity of the inferior alveolar canal as a predictor of paresthesia after third-molar extraction concluded loss of IAC cortical integrity is associated with an increased risk of experiencing paresthesia after mandibular third molar extraction.

Atieh MA., [16] in his study suggest a reasonable diagnostic accuracy for panoramic radiography in the preoperative evaluation of the relationship between third molars and the canal. Additional studies are needed to examine a more accurate, accessible, and cost-effective initial radiographic technique before third molar surgery.

Yu SK., *et al*. [17] said the root apex of the mandibular third molar was positioned more buccally in the vertical group than in the mesio-angular group.

Schulze D., *et al*. [18] concluded Selection of the most appropriate imaging modality should be per-formed in view of the delivered doses, required image quality and information and the clinical circumstances.

Kamburoglu K., *et al.* [19], suggests that efforts should be made to improve students' knowledge base regarding CBCT and that the dental school curriculum should devote more curriculum time to this promising new technology.

Article by Scarfe WC [20] on x-ray cone-beam CT (CBCT) acquisition provides an overview of the fundamental principles of operation of this technology and the influence of geometric and soft-ware parameters on image quality and patient radiation dose. Advantages of the CBCT system and a summary of the uses and limitations of the images produced are discussed. All current generations of CBCT systems provide useful diagnostic images. Future enhancements most likely will be directed toward reducing scan time; providing multimodal imaging; improving image fidelity, including soft tissue contrast; and incorporating task-specific protocols to minimize patient dose.

Study by Ghaeminia H., *et al*. [21] investigated the diagnostic accuracy of cone beam computed tomography (CBCT) compared to panoramic radiography in determining the anatomical position of the impacted third molar in relation with the mandibular canal. The study sample comprised 53 third molars from 40 patients with an increased risk of inferior alveolar nerve (IAN) injury. The panoramic and CBCT features (predictive variables) were correlated with IAN exposure and in-jury (outcome variables). Sensitivity and specificity of modalities in predicting IAN exposure were compared. The IAN was exposed in 23 cases during third molar removal and injury occurred in 5 patients. No significant difference in sensitivity and specificity was found between both modalities in predicting IAN exposure. To date, lingual position of the mandibular canal was significantly associated with IAN injury. CBCT was not more accurate at predicting IAN exposure during third molar removal, however, did elucidate the 3D relationship of the third molar root to the mandibular canal; the coronal sections allowed a bucco-lingual appreciation of the mandibular canal to identify cases in which a lingually placed IAN is at risk during surgery. This observation dictates the surgical approach how to remove the third molar, so the IAN will not be subjected to pressure.

Sisman Y., *et al*. [22], studied Diagnostic accuracy of cone-beam CT compared with panoramic images in predicting retro molar canal during extraction of impacted mandibular third molars.

His findings suggest that the MRC isn't a rare anatomical structure. This study therefore clearly establishes the incidence and importance of the MRC. The detection of the presence of the MRC using CBCT may be crucial for extraction of mandibular third molars.

Kanagaratnam R [23], studied Comparison of Orthopantomograph and cone beam computed tomography as pre-operative diagnostic tools for lower third molar surgery. He stated that to date the OPG examination remains the standard pre-operative examination. This was despite evidence that CBCT is significantly better, Tantanapornkul., *et al*. It could be argued that the increase in radiation exposure to gain additional information is warranted if the CBCT was significantly better than OPG. Perhaps there was room for argument that CBCT will replace OPG in the future. His research shows that there was evidence to support the use of combined examination methods. Furthermore there was evidence that use of CBCT alone may soon have preference for initial pre-operative examinations.

Szalma J [24], studied the role of Panoramic radiography in the prediction of inferior alveolar nerve injury after mandibular third molar surgical removal. It was a case-control model. 116 mandibular third molar surgical extraction cases -showing darkening of the third molar roots on pre surgical panoramic radiographs- were selected for the case group and 193 cases without darkening were selected for control. According to their research results they can conclude that the relatively low positive predictive values of "high-risk" signs indicate panoramic radiography for an inadequate diagnostic method predicting IAN paresthesia after mandibular third molar surgery. However the preoperative analysis of Panoramic radiographs seems to be mandatory.

Sarikov R., *et al.* [25], did a literature review of inferior alveolar nerve injury after mandibular third molar extraction. Literature was selected through a search of PubMed electronic databases. Articles from January 2009 to June 2014 were searched. English language articles with a minimum of 6 months patient follow-up and injury analysis by patient reporting, radiographic, and neurosensory testing were selected. In total, 84 literature sources were reviewed, and 14 of the most relevant articles that are suitable to the criteria were selected. Articles were analyzed on men and women. The influence of lower third molar extraction (especially impacted) on the inferior alveolar nerve was clearly seen. The incidence of injury to the inferior alveolar nerve after lower third molar extraction was about 0.35 - 8.4%. The injury of the inferior alveolar nerve can be predicted by various radiological signs. There are few risk factors that may increase the risk of injury to the nerve such as patients over the age of 24 years old, with horizontal impactions, and extraction by trainee surgeons. Recovery is preferable and permanent injury is very rare.

Mehdizadeh M., *et al*. [26], did a cross sectional study with convenience sampling of 94 samples. Their results showed differences in the position of inferior alveolar nerve with different views of CBCT, so CBCT views are not quite reliable and have possibility of error.

Saraydar-Baser R., *et al*. [27] did comparison of the diagnostic value of CBCT and digital panoramic radiography with surgical findings to determine the proximity of an impacted third mandibular molar to the inferior alveolar nerve canal. This was descriptive-analytic research applied CBCT and panoramic radiographs for 60 subjects. Eight cases showed positive surgical findings indicating vicinity of the third molar and the mandibular nerve canal. Only 13.3% of the cases in which panoramic views showed the proximity of the mandibular third molar and the inferior alveolar canal were confirmed during surgery. The result for CBCT radiographic diagnosis was 95%. It was concluded that CBCT is preferred over panoramic radiography to determine the proximity of the impacted mandibular third molar to the mandibular canal. Narrowing of the mandibular canal or root canal, disconnection of root borders in panoramic radiography, and the inferior-lingual proximity of the tooth to the root in CBCT strongly indicated the close nearness of the impacted mandibular third molar to the mandibular canal.

Materials and Method

Source of data

Present study is descriptive analytical in vivo study done on patients coming to OPD of Oral Medicine and Radiology Department of Dr. D.Y. Patil Dental College and Hospital for mandibular third molar evaluation. Study was conducted at Dr. D.Y. Patil Dental College and Hospital, Pimpri, Pune. The study will be conducted with a sample size of 34 mandibular third molars. It consists of 21 female and 13 males of Maharashtrian population in the age group between 19 and 60 years.

Method of Data Collection

Sample size of 34 was calculated using consecutive sampling technique. Following inclusion and exclusion criteria was used for the study cases selection.

Inclusion criteria

1. All the patients would be above 18 years of age.
2. Patients coming for mandibular third molar evaluation.
3. Patients willing to undergo CBCT scan.
4. Patients willing to give a written informed consent and follow the schedule.

Exclusion criteria

1. Patients without approximation of mandibular third molar to mandibular canal on conventional radiograph.
2. Patients with cysts, tumors or space infections in mandibular third molar region.
3. Patients with Maxillofacial trauma or any History of maxillofacial trauma.
4. Patients not willing to participate.

Patients coming to OPD of Oral Medicine and Radiology department were clinically evaluated which showed sign and symptoms of third molar impaction. Panoramic radiograph was taken for these patient on Planmeca machine and the software used was Romexis software with exposure parameters of 70 KV, 10 mA, 18 sec. Assessment of four radiographic markers (darkening of the root, interruption of mandibular canal wall, mandibular canal diversion, root dilacerations) were done as primary screening. Patient showing at least one of the radiographic marker were taken for the study. Such 34 patient underwent CBCT scan on i-Cat CBCT machine and vision software was used to study the scans. Assessment of presence or absence of direct contact between the mandibular third molar roots and the mandibular canal on CBCT scan in patients with any of the above radiographic marker was confirmed.

Illustration 1

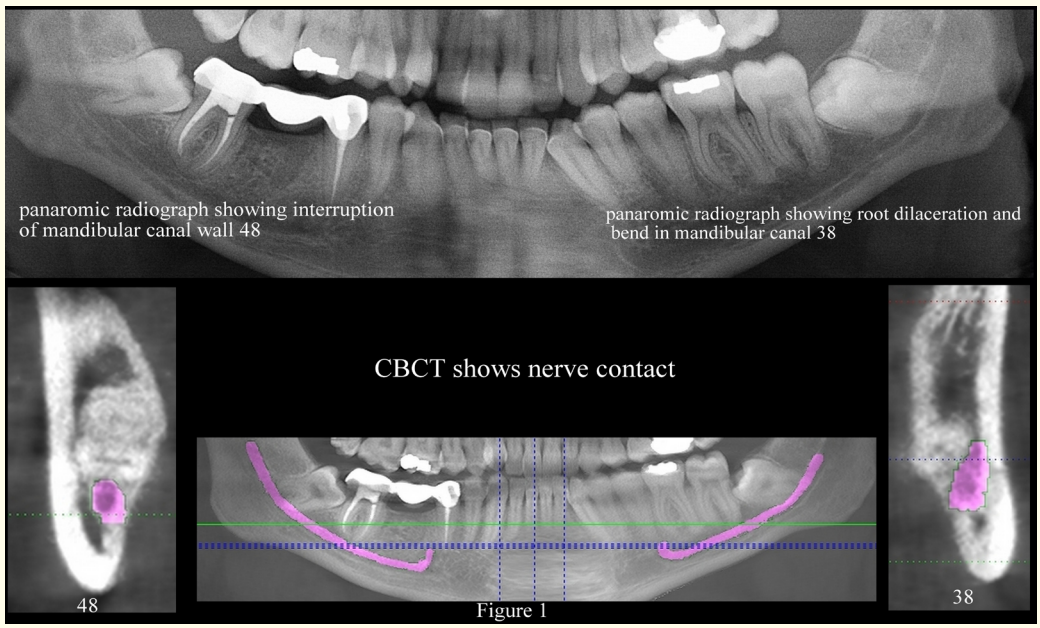

Figure 1: *Illustration showing OPG and CBCT.*

Illustration 2

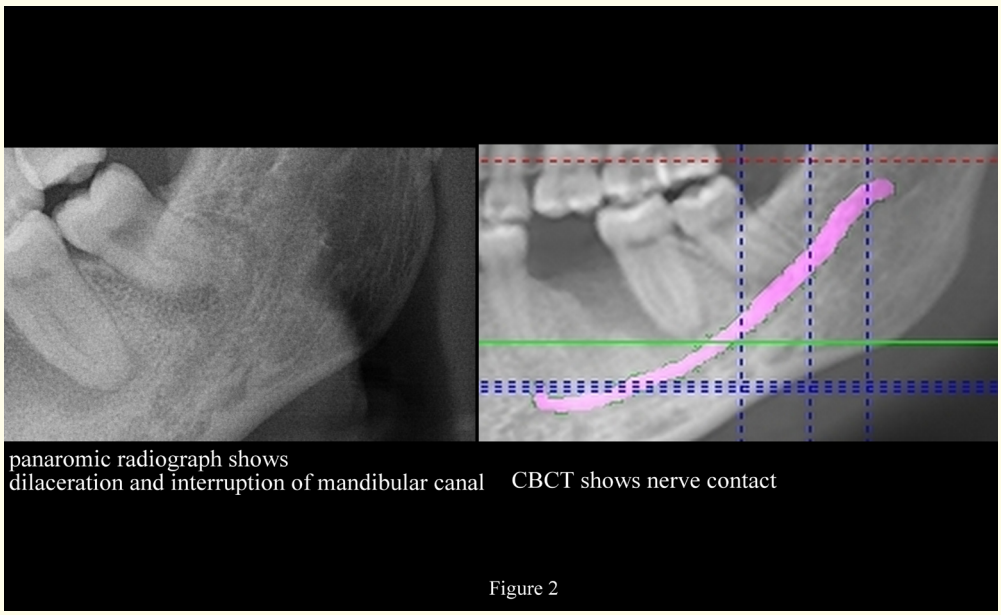

Figure 2: *Illustration showing cropped images of OPG and CBCT.*

Illustration 3

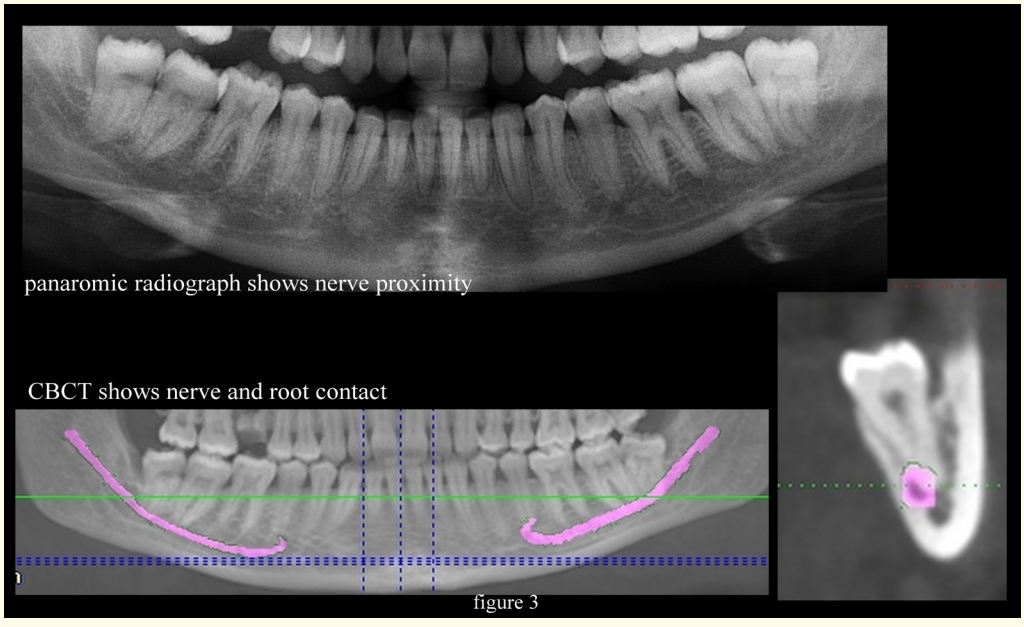

Figure 3: *Illustration showing OPG and CBCT Panoramic view and coronal section.*

Illustration 4

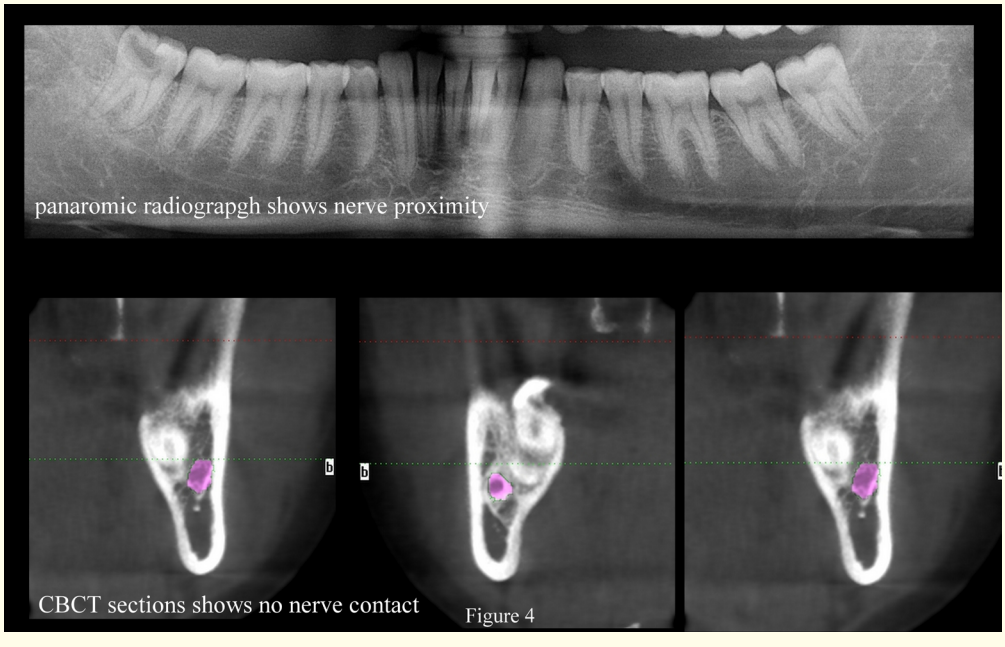

Figure 4: *Illustration showing OPG and CBCT coronal sections.*

Results

Sample size of 34 consisted of 13 males and 21 female patient between 19 to 60 years of age group.

Gender Distribution	Male	Female
	13	21

Table 1: *Gender distribution in sample.*

Four markers (Darkening of roots, interruption of canal wall, mandibular canal diversion and root dilacerations) were studied in comparison with CBCT.

Marker	Occurrence	Contact confirmed on CBCT
1. Darkening of root	14%	80%
2. Interruption of canal wall	20%	85%
3. Mandibular canal diversion	17%	100%
4. Dilacerations of root.	64%	68%

Table 2: *OPG marker and its occurrence and contact to radiographs will be calculated as confirmed on CBCT. Four markers (Darkening of roots, interruption of canal wall, mandibular canal diversion and root dilacerations) were studied in comparison with CBCT.*

Occurrence: Indicate percentage of presence of that particular marker in the sample.

Contact: Indicate percentage of contact to nerve of particular marker confirmed on CBCT.

Statistical Analysis

Sensitivity, specificity, positive predictive value, negative predictive value, of Panoramic radiographs will be calculated as confirmed on CBCT.

	Marker	Sensitivity	Specificity	PPV	NPV
1	Darkening of roots	16%	80%	80%	27%
2	Interruption of canal wall	24%	88%	85%	29%
3	Mandibular canal diversion	5%	40%	10%	24%
4	Dilacerations of roots	62%	30%	68%	25%

Table 3: *Showing sensitivity, specificity, PPV, and NPV of OPG markers.*

PPV: Positive Predictive Value; NPV: Negative Predictive Value

MASTER CHART

ID	Patient Name	Tooth No.	Marker1	Marker2	Marker3	Marker4	CBCT
1	Jalandhar Khaladkar	48				1	0
2	Jalandhar Khaladkar	38				1	1
3	Nidhi Vijay	48				1	1
4	Nidhi Vijay	38				1	1
5	Balekundri Priya	48			1		1
6	Balekundri Priya	38			1		1
7	Hemlata Khaladkar	48				1	1
8	Hemlata Khaladkar	38				1	1
9	Jambhale Vanita	38		1		1	1
10	Jambhale Vanita	48		1			0
11	Ashutosh Mahamuni	38				1	0
12	Pravin Chate	38				1	0
13	Pravin Chate	48				1	0
14	Vaishali Sonar	38	1				1
15	Vaishali Sonar	48				1	1
16	Sunanda Patil	38		1			1
17	Sunanda Patil	48				1	0
18	Rekha Pawar	48		1			1
19	Apurva Kale	38			1		1
20	Apurva Kale	48				1	0
21	Ganesh Awad	38		1			1
22	Ganesh Awad	48				1	0
23	Gayatri Nikalje	38			1	1	1
24	Gayatri Nikalje	48			1	1	1
25	Vaibhav Jathar	38		1			1
26	Vaibhav Jathar	48				1	1
27	Chetan Joshi	38			1	1	1
28	Chetan Joshi	48		1			1
29	Tabassum Sayad	38				1	1
30	Tabassum Sayad	48				1	1
31	Manish Dhedia	38	1				1
32	Manish Dhedia	48	1				0
33	Nutan Bhagwat	38	1			1	1
34	Nutan Bhagwat	48	1			1	1

0- No Contact 1- Contact

Marker 1: Darkening of Root; Marker 2: Interruption in Canal Wall; Marker 3: Mandibular Canal Diversion; Marker 4: Dilaceration of Roots

Discussion

There is incidence of dysesthesia and paresthesia caused after transalveolar extraction of mandibular third molar. It is due to injury to inferior alveolar nerve or sometimes due to lingual nerve injury. Inferior alveolar nerve can be present in close association with the roots of mandibular third molar. Chances of nerve injury increases with increase in the proximity between mandibular third molar roots and inferior alveolar nerve. Recovery from the nerve injury is slow. If the dam-age is permanent it is often distressing to the patient. This complications can be avoided by meticulous examination of mandibular third molar prior to its removal.

Panoramic radiography is the commonest method for screening the third molars before surgical procedure. Panoramic radiography do not show loss of cortication around the inferior alveolar canal. Location of mandibular third molar in bucco-lingual aspect cannot be studied on 2 dimensional Panoramic radiography. Several radiological markers are given in literature to examine the mandibular third molar and mandibular canal proximity on Panoramic radiograph. Amongst all the radiological markers darkening of roots, interruption of mandibular canal wall, bend in mandibular canal, and root dilacerations are the most common.

CBCT is three dimensional radiological modality which gives accurate information about the relation between mandibular third molar and mandibular canal. CBCT is a specialized technique and is not readily available everywhere. CBCT is also costly as compared to Panoramic radio-graph. If the radiological marker present on Panoramic radiograph can predict the proximity of the mandibular third molar and mandibular canal there is no need for advance imaging modality. Advance three dimensional imaging modality can only be prescribed based on the clinical judgement and only after conventional two dimensional radiological imaging modality.

Present study is designed to find the reliability of four (darkening of roots, interruption of mandibular canal wall, bend in mandibular canal, and root dilacerations) radiological markers seen on Panoramic radiograph in determining the proximity of mandibular third molar roots to mandibular canal.

Present study consisted of 34 third molars. There were 13 males and 21 female patient between 19 to 60 years of age group.

Root dilacerations was considered as risk factor by kim jw [6]. Root dilacerations were found in 22 mandibular third molar out of 34 samples. Occurrence of root dilacerations was highest (64%) in our study. 15 mandibular third molars out of 22 mandibular third molar with root dilacerations showed direct contact with mandibular nerve on CBCT. Root dilacerations showed the highest sensitivity (62.5%) among the four radiological marker. This finding suggested that roots changed their direction of development during formation rather than mandibular canal diversion. Sachin Pathak., *et al*. [6] mentioned hooked root (dilacerations of roots) as second most significant association in developing post-operative paresthesia after extraction of mandibular third molar. This is in contrast to study done by Sholeh Shahidi., *et al*. [7] in which interruption in mandible canal wall showed the highest sensitivity. This difference might be due to small sample size in our study and selection of the patient. In their study, positive predictive value (PPV) was highest for dilacerations of roots and darkening of roots [7]. Our study showed 68% of positive predictive value for root dilacerations which was less as compared to darkening of root (80%) and interruption of mandibular canal wall (85%). Though it was more than mandibular canal diversion (10%). Root dilacerations showed lowest specificity in our study (30%).

Interruption of mandibular canal wall was seen in 7 mandibular third molars out of 34 samples (20%). 85% cases of mandibular third molar showing interruption of mandibular canal wall showed contact with the mandibular nerve on CBCT. Interruption of mandibular canal wall showed sensitivity of (24%) which is second highest after root dilacerations. This result was in accordance with the study of shoeleh shahidi., *et al* [7]. Shoeleh shahidi., *et al*. proposed that there is close proximity of mandibular third molar and mandibular canal in the absence of white lines on Panoramic radiograph. In our study, positive predictive value (PPV) was highest for interruption of mandibular canal wall (85%). Also interruption of mandibular canal wall showed highest specificity (88%).

Darkening of roots was seen in 5 samples out of 34 samples of mandibular third molars. 80% of mandibular third molar showing darkening of roots showed direct contact with mandibular nerve as seen on CBCT. Darkening of root has reported to show proximity between third molar roots and mandibular canal by several studies [7]. Tantanapornkul W., *et al*. [12] believed that this radio-graphic marker indicated thinning or perforation of lingual cortical plate. Study of Sachin Pathak., *et al*. [6] proposed darkening of roots as statistically non-significant in developing post-operative paresthesia. In our study darkening of root showed very less sensitivity compared to root dilacerations and interruption of mandibular canal wall. Positive predictive value was more than root dilacerations in this study. Also darkening of roots showed 80% specificity.

Our study showed the course of canal was buccally positioned in respect to mandibular third molar which is in accordance with the study done by Monaco., *et al* [13]. On the other hand, Tan-tanapornkul W., *et al*. [12] found that maximum number of mandibular canal were situated lingual to third molar.

Six mandibular third molars showed mandibular canal diversion out of 34 study cases, and all six cases showed direct contact with mandibular nerve when confirmed on CBCT. Mandibular canal diversion showed least sensitivity (5%) which supported study done by sholeh shahidi., *et al* [7]. Study of Sachin Pathak., *et al*. [6] proposed mandibular canal diversion as insignificant in developing post-operative paresthesia. Mandibular canal diversion showed least positive predictive value as compared to all other radiographic markers.

Present study shows root dilacerations has highest reliability followed by interruption of mandibular canal wall in determining the proximity of mandibular third molar to mandibular canal. Mandibular canal diversion and darkening of roots has least reliability in our study in detecting the proximity between mandibular third molars and mandibular canal.

In our study, 6 third molar showed more than one marker. In all the sample dilacerations of roots was the common radiographic marker. The risk increased with these patient showing two markers simultaneously. In this study intactness of the cortex of the mandibular canal in CBCT is also considered as contact, thus it is hard to predict the true contact. In our study different radio-graphic marker are proposed as factors related to close proximity of inferior alveolar nerve and mandibular third molar. Presence or absence of radiographic marker on Panoramic radiography neither completely predicts the proximity of mandibular canal to roots of third molar nor completely denies the existence of such relationship. As we included patient showing at least one of the marker on Panoramic radiograph, cases were contact is there in the absence of specific marker cannot be studied. Also we found few cases were radiographic marker was evident of Panoramic radiograph but there was no contact on CBCT.

Even if there was a way to predict the relationship between canal and tooth correctly through determining the presence or absence of different markers in panoramic radiography, still the exact location of the mandibular canal its path (direction) could not be evaluated due to the two-dimensional nature of panoramic radiography it is better to determine this issue through three-dimensional radiographic examinations. Three dimensional imaging such as CBCT can also pro-vide the surgeon with other information such as narrowing or puncturing of the lingual cortex by root which can result in decreasing the risk of injury to the lingual nerve, fracture of the lingual cortex, or displacement of tooth or bone into the soft tissues at the floor of the mouth [5]. There-fore, the exact information will provide the patient with enough information and a better under-standing of the process of surgery and its relevant risk.

According to many published studies the sensitivity of Panoramic radiography ranges from 42 - 85.7% [8] but in our study considering, darkening of roots, interruption of mandibular canal wall, bend in mandibular canal, and root dilacerations as the radiographic markers the sensitivity of Panoramic radiography ranges from 5-62%. This difference may be due to choice of markers studied, selection of patient and low sample size.

Panoramic radiograph has reliability in predicting the proximity between mandibular third molar root and mandibular canal depending upon the radiographic markers. These radiographic marker aid in detection of the proximity and can indicate the need of higher radiographic imaging modality. Panoramic radiograph should be used for primary screening and CBCT can be advised only depending upon the investigations seen on Panoramic radiograph.

Conclusion

Panoramic radiograph should be primary screening radiographic modality for detecting the proximity between mandibular third molar and mandibular canal. Root dilacerations is the most sensitive marker and interruption in mandibular canal wall is most specific marker. Presence of this markers shows close proximity of the mandibular canal to the mandibular nerve. So precautions should be taken while performing the surgery to avoid possible complications. Presence of these markers and dilemma in predicting the proximity between mandibular third molar and mandibular canal necessitate the use of advance imaging modality such as CBCT.

Summary

Present study was conducted in department of Oral Medicine and radiology of Dr. D Y Patil Dental College, Pune. Pre-operative evaluation of mandibular canal and its proximity to third molar roots is important to avoid post-operative complications of third molar removal surgery. Appropriate management of impacted third molars require precise diagnosis regarding location of impacted teeth and its relationship with surrounding morphological structures. There is inferior alveolar nerve canal in proximity to third molars and impaction of these molars further increases the proximity. Transalveolar extraction of mandibular third molar may result in damage to inferior alveolar neurovascular bundle. Neurological damage to the nerve occurs due to improper diagnosis of tooth with surrounding structure or inappropriate surgical method employed. Imaging modality is used for the correct diagnosis and study of anatomy near third molars. 2 dimensional imaging modality such as OPG is used for initial screening. Though 3 dimensional structure of third molar and mandibular cannot be diagnosed by 2 dimensional imaging modality. But with the help of some marker on Panoramic radiography proximity of third molar root and mandibular canal can be estimated. Wherein minimizing the use of advance imaging modality such as CBCT. Also CBCT is not always available everywhere and it is also not economical. Also these marker can be taken as the warning signs and then only the CBCT can be prescribed. Panoramic radio-graph should be primary screening radiographic modality for detecting the proximity between mandibular third molar and mandibular canal. Presence of these markers and dilemma in predicting the proximity between mandibular third molar and mandibular canal necessitate the use of advance imaging modality such as CBCT.

Bibliography

1. Singh k., *et al*. "Panoramic Radiograph and cone beam computed tomography- evaluation of Mandibular impacted third molar and Mandibular canal". *Caribbean Journal of Science and Technology* 2 (2014): 663-668.

2. Mela O., *et al*. "Assessment of the Relationship between the Mandibular Canal and Impacted Third Molars Using Cone Beam Computed Tomography". *Mansoura Journal of Dentistry* 1.3 (2014): 49-55.

3. Shujaat S., *et al*. "Pre-operative assessment of relationship between inferior dental nerve canal and mandibular impacted third molar in Saudi population". *The Saudi Dental Journal* 26.3 (2014): 103-107.

4. Dalili Z., *et al*. "Comparison between cone beam computed tomography and panoramic radiography in the assessment of the relationship between the mandibular canal and impacted class C mandibular third molars". *Dental Research Journal* 8.4 (2011): 203-210.

5. Ebrahimifard T., *et al*. "The Validity of the Panoramic Radiography in Evaluating the Topo-graphic Relationship between Mandibular Canal and Impacted Third Molars in Comparison with Cone Beam CT-scan". *Zahedan Journal of Research in Medical Sciences* 15.1 (2013): 28-33.

6. Pathak S., *et al*. "Significance of Radiological Variables Studied on Orthopantamogram to Pre-dict Post-Operative Inferior Alveolar Nerve Paresthesia after Third Molar Extraction". *Journal of Clinical and Diagnostic Research* 8.5 (2014): ZC62-ZC64.

7. Shahidi S., *et al*. "Comparison of panoramic radiography with cone beam CT in predicting the relationship of the mandibular third molar roots to the alveolar canal". *Imaging Science in Dentistry* 43.2 (2013): 105-109.

8. Palma-Carrió C. "Radiographic signs associated with inferior alveolar nerve damage following lower third molar extraction". *Medicina Oral Patologia Oral y Cirugia Bucal* 15.6 (2010): e886-e890.

9. Sinha P and Pai A. "Assessment of proximity of impacted mandibular third molar roots to the mandibular canal using intra oral periapical radiography and cone-beam computerized tomography: A comparative study". *International Dental and Medical Journal of Advanced Research* 1 (2015): 1-5.

10. Yabroudi F and Pedersen S. "Cone Beam Tomography (CBCT) as a Diagnostic Tool to Assess the Relationship between the Inferior Alveolar Nerve and Roots of Mandibular Wisdom Teeth". *Smile Dental Journal* 7.3 (2012): 12-17.

11. Peker I., *et al*. "Panoramic radiography and cone-beam computed tomography findings in pre-operative examination of impacted mandibular third molars". *BMC Oral Health* 14 (2014): 71.

12. Tantanapornkul W., *et al*. "A comparative study of cone-beam computed tomography and conventional panoramic radiography in assessing the topographic relationship between the mandibular canal and impacted third molars". *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontics* 103.2 (2007): 253-259.

13. Monaco G., *et al*. "Reliability of panoramic radiography in evaluating the topographic relation-ship between the mandibular canal and impacted third molars". *Journal of the American Dental Association* 135.3 (2004): 312-318.

14. Blaeser BF., *et al*. "Panoramic radiographic risk factors for inferior alveolar nerve injury after third molar extraction". *Journal of Oral and Maxillofacial Surgery* 61.4 (2003): 417-421.

15. Park W., *et al*. "Cortical integrity of the inferior alveo-lar canal as a predictor of paresthesia after third-molar extraction". *Journal of the American Dental Association* 141.3 (2010): 271-278.

16. Atieh MA. "Diagnostic accuracy of panoramic radiography in determining relationship be-tween inferior alveolar nerve and mandibular third molar". *Journal of Oral and Maxillofacial Surgery* 68.1 (2010): 74-82.

17. Yu SK., *et al*. "Positional relationship between mandibular third molar and mandibular canal in cone beam computed tomographs". *Korean Journal of Oral and Maxillofacial Radiology* 37.4 (2007): 197-203.

18. Schulze D., *et al*. "Radiation exposure during mid-facial imaging using 4-and 16-slice computed tomography, cone beam computed tomography systems and conventional radiography". *Dento-maxillofacial Radiology* 33.2 (2004): 83-86.

19. Kamburoglu K., *et al*. "Dental student's knowledge and attitudes towards cone beam tomography in Turkey". *Dento-maxillofacial Radiology* 40.7 (2011): 439-443.

20. Scarfe WC and Farman AG. "What is cone-beam CT and how does it work?" *Dental Clinics of North America* 52.4 (2008): 707-730.

21. Ghaeminia H., *et al*. "Position of the im-pacted third molar in relation to the mandibular canal. Diagnostic accuracy of cone beam computed tomography compared with panoramic radiography". *International Journal of Oral and Maxillofacial Surgery* 38.9 (2009): 964-971.

22. Sisman Y., *et al*. "Diagnostic accuracy of cone-beam CT compared with panoramic images in predicting retromolar canal during extraction of impacted mandibular third molars". *Medicina Oral Patologia Oral y Cirugia Bucal* 20.1 (2015): e74-e81.

23. Kanagaratnam R. "Comparative Study of Orthopantomograph and Cone Beam Computed Tomography As Pre-operative Diagnostic Tools For Lower Third Molar Surgery". University of Sydney (2014).

24. Szalma J. "The role of Panaromic radiography in the prediction of inferior alveolar nerve inju-ry after mandibular third molar surgical removal". University of Pécs (2011).

25. Sarikov R and Juodzbaly G. "Inferior Alveolar Nerve Injury after Mandibular Third Molar Ex-traction: a Literature Review". *Journal of Oral and Maxillofacial Research* 5.4 (2014): e1.

26. Mehdizadeh M., *et al*. "Evaluation of relationship between mandibular third molar and mandibular canal by different algorithms of cone beam computed tomography". *The Journal of Contemporary Dental Practices* 15.6 (2014): 740-745.

27. Saraydar-Baser R., *et al*. "Comparison of the diagnostic value of CBCT and Digital Panoramic Radiography with surgical findings to determine the proximity of an impacted third mandibular molar to the inferior alveolar nerve canal". *Journal of Medicine and Life* 8.3 (2015): 83-89.

Volume 17 Issue 3 March 2018