

**Assessment of Root Apex Position of Mandibular
Molars and Premolars linear to Inferior Alveolar
Canal among a sample of Egyptian Population
Using CBCT: A Cross sectional study**

Protocol

**submitted to Faculty of Dentistry, Cairo University for partial
fulfillment of the requirements for Master Degree in Oral and
Maxillofacial Radiology**

Research code :Rad 2:5:1

05/09/2018

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Introduction

The inferior alveolar nerve (IAN) position is important in avoiding nerve damage during invasive dental procedures. The inferior alveolar bundle is located in the mandibular canal, which runs obliquely through the ramus of the mandible and horizontally through the mandible. The components of the inferior alveolar neurovascular bundle, which is the major supplier of both sensation and blood to the mandible, are arranged consecutively from the superior to inferior positions as follows: vein, artery, and nerve (**Yu, Lee, Jeon, Chung, & Kim et al 2016**). The IAN, which is a branch of the mandibular nerve (the third branch of trigeminal nerve),is prone to injury due to trauma, tumors , and a variety of surgical treatments. The IAN provides innervation to the mandibular molars and premolars and their gingiva. The incisive branch, an extension of the IAN, supplies the anterior teeth (**Juodzbalys, Wang, & Sabalys et al 2011**).

The dental procedures posterior to the mental foramen increases the risk for injuring the IAN as a result of its proximity to the root apices of mandibular premolars and molars (**Pogrel et al 2007;Valmaseda et al 2001**).The dental procedures may be endodontic procedures (**Pogrel et al 2007;Escoda et al 2007**), implant placements (**Burstein et al 2008;kraut et al 2002**), or extraction of mandibular third molar (**Valmaseda et al 2001**) can cause injury to IAN, or implant placement ,resulting in neuropathic pain or partial or complete numbness in the chin area(**Microsc et al 2017**).

Endodontic therapy might also damage the IAN. Several mechanisms have been proposed, including (1) neurotoxic effect from root canal filling material penetrating the IAN (**Pogrel et al 2007;Valmaseda et al 2001**); (2) mechanical pressure on the nerve caused by overextension of filling material or over

instrumentation with hand or rotary files (**Pogrel et al 2007; Valmaseda et al 2001**); IAN damage has been suggested to occur in 1% of mandibular premolars that receive root canal treatment (**Escoda et al 2007**).

There is an incidence for nerve injury during dental implant placement, resulting from the poor assessment of bone length or excessive length of implant bodies. Therefore to avoid damage of inferior alveolar nerve, it is important to assess the mandibular canal location in the mandible and edentulous space that represent the missing tooth. (**Jui-Ting Hsu et al 2013**)

The nerve injury is unfavorable consequences for the patient (**Escoda et al 2007; Burstein et al 2008**). If an intimate relation exists, this may have clinical relevance and risk of nerve injury implications in relation to root canal treatment and dental placement of mandibular premolars and molars

Rational of the Study

The linear relation between mandibular premolar and mandibular molars to inferior alveolar canal is not correlated; this study may help to reduce IAN injury during dental and surgical procedures.

Statement of the Problem

Direct nerve damage may be caused by placement of implants, or surgical extraction, or endodontic treatment. All of these may cause temporary or permanent damage to the IAN (**poveda et al 2006; Lvovsky et al 2018**). These procedure are invasive, and the nerve may be close to the root apex of the posterior teeth. So the clinical relation between inferior alveolar canal and apices of roots of mandibular premolar and molar is important to avoid nerve damage.

Review of literature

List of main databases used in search:

- Pubmed
- Google Scholar

Keywords:

- Cone-beam computed tomography- Inferior Alveolar Nerve-Mandibular Premolars- Mandibular Molars -Nerve Injury.

Various dental procedures distal to mental foramen pose a potential iatrogenic cause of inferior alveolar nerve injury (**Escoda et al 2007**), The dental procedures include the surgical and non-surgical procedural, they include the endodontic treatment, implant placement, or extraction of third mandibular molar (**kovisto et al 2011**).

In endodontic treatment obturation, gutta percha is traditionally considered an inert root-filling material, the paresthesia's cases involving gutta percha results from overfill of thermoplastic gutta-percha. If the sealers are excluded from the apices in the mandibular canal space, it can cause nerve injury (**Hiremath et al 2016**).

Injury to the IAN has also been shown with extraction of mandibular third molars (frequency of 1.3%), suggesting that teeth are often close to the nerve. In patients with mental nerve injury, extraction and implant placement have been implicated in 63% of cases with problems (**Kalladka et al 2008**). **Hidenobu et al** reported the relation of third mandibular molar and position of the inferior alveolar nerve without reporting the root apices relation to the nerve.

One of the dentists' objectives is to retain the nature tooth, but if loss of tooth structure, periodontal disease, or trauma is severe, the tooth might be un-restorable. To replace a lost tooth, the treatment option is placement of dental implant to replace the extracted tooth. Immediate implant placement, with apical penetration of the

implant 4–5 mm beyond the previous position of the tooth root into bone for stabilization, can cause injury to the nerve. If the IAN is in close proximity to the root apex of the tooth extracted, implant placement 4–5 mm below the apex of the socket of extracted tooth might cause injury to the nerve. Nerve damage has been reported in 17% of implant cases (**Kubilius et al 2004**). Paresthesia can be as high as 13% in the posterior mandible from implants (**Burstein et al 2008**). Neurosensory problems can be as high as 52% in patients who have received a dental implant (**Kovisto et al 2011**). Although IAN damage is infrequent and the prevalence is not well-defined, it is a serious situation that has unfavorable complication for the patient. Before going procedures with potential for IAN injury, it is critical to determine the location of the inferior alveolar canal with respect to the surrounding structures to avoid injury of anatomical structure (**Burstein et al 2008**).

Jerjes et al 2005 has reported also that the paresthesia of inferior alveolar nerve may result from infection as inflammatory cyst in correspondence with first and second mandibular premolars, while in the mandibular molars, the distance between the root apex and inferior alveolar canal should be in consideration. In the study by **Tilotta-Yasukawa et al 2006**, the distance of root apex of first mandibular molars from the inferior alveolar nerve varies from 1 and 4 mm and it is less than 1 mm with the second and third mandibular molars. For this reason, the spread of infectious cases to the inferior alveolar nerve that originates from apices of first or second mandibular molar may be quickly involved the nerve even if the periapical lesion size is small(**Rachele et al 2016**).

In infectious cases, the paresthesia can be the result of a combination of the following mechanisms.(1) *Mechanical Pressure*: In particular, the expanding infectious process can cause pressure on the nerve fibers. The pressure induces the paresthesia. (2) *Microbial Products*: in which the products of certain microbes (gram

negative bacteria) can puncture the perineurium with resultant nerve bundle impairment and soiled the conduction.

In view of these potential complications, several studies were conducted to assess the distances between inferior alveolar canal and the root apices of mandibular premolars and molars. However, most studies included only a limited number of specimens (**Kim et al 2010**) or were based on orthogonal and eccentric periapical radiographs or on panoramic radiographs. The value of such analyses is limited because of superimpositions of surrounding structures or distortions (**Bürklein et al 2015**). Although there is too many studies correlate the relation of third molars to inferior alveolar canal ,and also too many studies correlate the relation of molars to the buccal-lingual cortical bone. There is no relation of root apices of the mandibular premolars and molars to the inferior alveolar nerve in a sample of Egyptian population.

Cone-beam computed tomographic (CBCT) imaging provides 3-dimensional (3D) images with a moderate radiation dose (**Patel et al 2014**), and numerous studies have reported its value in diagnosing spatial relationships between anatomic structures (**Temple et al 2016; Tahmasbi et al 2017**). So spatial proximity of vital structures such as the inferior alveolar nerve, the incisive canal, and the mental foramen can be accurately assessed and measured (**Benavides et al 2012**). CBCT can overcome the limitations of radiographs by providing an accurate and 3D image of teeth and surrounding structures. CBCT scans were found to have an error less than that 0.6 % when measuring mandibular anatomy(**Ludlow et al 2007**). The advantages of CBCT are the weaknesses of 2D intraoral periapical and panoramic radiographic representations. The ability to visualize the area of interest and avoid superimposition permits accurate radiographic interpretation. So it is useful to assess the position of root apex of first and second premolar and mandibular molars to IAN. In other conventional radiographic techniques, there

are distortion and magnification of the anatomic structures ranging from 3.4% for periapical radiographs to more than 14% for panoramic radiographs (**Lazzerini et al 1996**).

Aim of the Study

The aim of the study is to assess the linear position between the roots of mandibular premolars and molars and the superior border of inferior alveolar canal.

Population: Adults, male and female from Egyptian population

Outcome Variable: Linear measurement of the distance between root apices of mandibular premolars and molars to the superior border of IAN.

	Outcome Measured	Measuring Device	Measuring Unit
Primary Outcome	Distance between root apices of mandibular premolars and molars to inferior alveolar canal	CBCT software Romexis®	Millimeters

Research question:

Among the mandibular premolars and molars, which roots are the closest to the inferior alveolar canal, in sample of Egyptian Population?

Materials and Methods

Study Design: Cross-sectional Study

Setting and Location:

- 1- The data collection will be obtained from the data base available at Oral & Maxillofacial Radiology department at faculty of Dentistry, Cairo University.
- 2- CBCT images will be obtained from Egyptian patients who had CBCT examination as part of their dental examination, diagnosis or treatment planning during the years 2018.

Participants:

A total of 162 CBCT scans of mandibular permanent premolars and molars belonging to Egyptian individuals are selected according to the following:

Inclusion criteria:

- First and second mandibular permanent premolars and molars of Egyptian patients starting from 18 years, males or females.
- Intact roots without fractures or cracks.
- Posterior teeth are present and their adjacent and opposing teeth.
- Absence of radiological evidence of dental malocclusion that could have altered the position of premolars or molars.
- CBCT scans of mandibular first and second premolars and molars using 20 x 10 cm FOV, 0.4mm voxel resolution.

Exclusion criteria:

- Evidence of apicectomy or periapical surgery.
- Odontogenic or non-odontogenic pathology.
- Congenital deformity of the mandible.
- External Root resorption.
- Previous history of fracture of the mandible.
- Tomographic images of poor quality or artifacts interfering with the detection of mandibular canal and apical morphology of the teeth.

Variables:

1. The crowding and overlapping of the mandibular posterior teeth .
2. Extraction of the adjacent or the opposing tooth may cause tilting of the tooth or over eruption of the opposing tooth.
3. Attrition of the teeth may cause over eruption of the teeth.
4. The presence of dental anomalies may influence the position of the tooth to the inferior alveolar canal.

Data Sources / Measurements:

Retrospective Data Analysis will be performed after the CBCT images are pooled from the computer database by convenient sampling technique.

CBCT images will be obtained from patients who required CBCT examination as part of their dental examination, diagnosis or treatment planning without exposing them to unnecessary radiation dose for the research purpose.

All the CBCT examinations are scanned by Planmeca Promax 3D®, 20 x 10 cm FOV, 0.4 mm voxel resolution, 90 kVp, 8 mA and 13.5 seconds exposure time.

To assess the shortest distance from the root apices to the border of the inferior alveolar canal, the multiplanar reconstruction view of the manufacturer's software viewer (Planmeca Romexis) with its axial, sagittal and coronal plane will be used, and the cross-sectional images through the mandible will be also used.

Cross sectional images will be oriented parallel to the long axis of the tooth, then the shortest distance from the deepest point of root apices and superior border of the inferior alveolar canal will be obtained to be examined (**Umut et al 2017**).

CBCT images will be interpreted by two oral radiologists independently; blinded from demographic data of the patients and from the results of each other.

All measurements will be assessed, once by the first investigator and then another time two weeks later for intra-observer reliability. The second investigator will assess the measurements once for inter-observer reliability.

Then inter-observational and intra-observational variability between the observers will be evaluated.

Bias:

No source of bias.

Study Size:

The aim of the study is to assess the relationship between the roots of mandibular premolars and molars and the superior border of inferior alveolar canal in Egyptian population. Based on the previous paper by **San Chong,et al,2017**,the prevalence of alveolar nerve 78%.Using a precision of 5, a design effect set at 1 with 95%CI(confidence interval), a total sample size of 162 will be sufficient. The sample size was calculated by Epi info.

Sampling Strategy: The sample will be collected by convenient sampling technique.

Statistical Methods:

Data will be analyzed using IBM SPSS advanced statistics (Statistical Package for Social Sciences), version 24 (SPSS Inc., Chicago, IL). Numerical data will be described as mean and standard deviation or median and range. Categorical data will be described as numbers and percentages. Comparisons between males and females for normally distributed numeric variables will be done using Student's t-test while for non-normally distributed numeric variables will be done by Mann-Whitney test. Comparisons between categorical variables will be performed using the chi square test. A p-value less than or equal to 0.05 will be considered statistically significant. All tests will be tailed.

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