Measurement of mandibular canal diameter using cone beam computed tomography. An experimental pilot study

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Abstract

Objective: In vitro study to consult a knowledge base about the superior-inferior diameter, bucco-lingual diameter and buccal and lingual bone thickness adjacent to mandibular canal.

Materials and methods: cone beam computed tomography scans of 170 patients were used to evaluate measurements from posterior mandibular area.

Results: 1-the buccal bone thickness over the mandibular canal was the thickest at the level of the mesial root of second molar with an average of (5.25 mm), and it was the thinnest at the level of first premolar with an average of (1.90 mm).

2- The lingual bone adjacent to mandibular canal was the thickest at the level of first premolar with an average of (4.96 mm) and it was the thinnest at the level of the distal root of first molar with an average (1.39 mm).

3- The average buccolingual diameter of the mandibular canal was (1.79 mm).

4- The superior-inferior diameter of the canal increase along the course of the canal from the first premolar to the second molar with an average diameter (2.07 mm).

Conclusion: Knowledge of the mandibular canal dimensions and thickness of buccal and lingual bone surrounding the mandibular canal is valuable to the surgeon and can provide a basis of information. CBCT is a valuable tool that offers advantages over conventional periapical and panoramic film**s.**

Keywords: CBCT, Mandibular canal.

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Introduction

Radiographic evaluation is one of the most effective instruments of root canal treatment, not only judging in the diagnosis, but also assisting in the treatment outcome. Due to the fact that the three-dimensional anatomy of the region being x-rayed is reduced to a two-dimensional image, information obtained from periapical radiography is therefore limited compared to that of cone beam computed tomography.

Before surgeries, it is important that the clinician be familiar with the anatomical landmarks and structures adjacent to the surgical location, particularly nerve location, and is a must for the planning and execution of the osteotomy and nerve decompression. If cone beam computed tomography is not available, it is important for the surgeon to obtain information about the surgical site. Knowledge of mandibular canal diameter and lingual and buccal bone thickness adjacent to the canal will assist the surgeon before and during the surgical procedures.

Previous studies have provided the surgeon with information about the anatomy of the mandibular posterior region. According to a study by **Durack et al.**1 that highlighted the uses, advantages, disadvantages and limitations of CBCT in management of endodontic problems. CBCT overcomes the limitations of conventional radiography which compresses 3D structures into 2D dimensional image. The radiation dose when using CBCT is higher than in conventional radiography. Prescription of CBCT scans in the management of endodontic cases must be made on a case-by-case basis and only when insufficient diagnostic data is available from other diagnostic tests.

Estrela et al.2 that evaluated the anatomic relationship between the apices of the posterior teeth and the maxillary sinus floor using 202 cone beam computed tomography (CBCT) images. They found that in comparison with premolars, the roots of the maxillary molars showed greater proximity to the maxillary sinus. Also the thickness of the cortical bone of the maxillary sinus floor in the region closest to the apex and furcation

area was found to be close only for premolars. **Ludlow et al.**3 evaluated the accuracy of cone beam computed tomography in measuring mandibular anatomy. CBCT scans of 28 skulls in ideal, shifted and rotated positions were assessed by measuring distances between anatomic points using reference wire using 2D panoramic reconstruction. Then direct measurements using axial views through 3D CBCT. Differences between measurements were calculated. They concluded that average errors for 2D panoramic measurements were less 1.2% while for CBCT measurements, average errors were less than 0.6%. During image processing, the CBCT measurements were not significantly affected by variations in skull orientation. Thus, the CBCT imaging of the skull may provide more detailed information for the anatomy of the mandibular canal and its relative location to the apices of the teeth, even in cases of slight distortion of the picture. **Kim et al.**4 conducted a study to compare between measurements of distance between lower posterior teeth apices and mandibular canal using CBCT and direct measurements in hemi-sectioned mandibles. They concluded that there was no statistical difference between the two methods of measurement, and CBCT can be used for measuring the distance between root apices and mandibular canal as precise as direct measurement in dissected mandible. Using 2D radiography has more limitations than CBCT, One of the most important limitation is the Three-dimensional anatomy compression into a two-dimensional image, resulting in misdiagnosis or underestimation of the size of **3** existing periapical pathosis in combination with geometric distortion and noise. 5,6

Kovisto et al.7 performed a retrospective study to know the proximity of mandibular canal to tooth apex using CBCT. Knowledge of relation of mandibular canal to tooth apices is important in avoiding nerve damage during invasive dental treatments. Although they provide useful information, some of these previous studies used older techniques such as tooth sectioning or lower

resolution medical CT scans which may have introduced error.

Materials and methods:

The following study was conducted retrospectively on previously acquired CBCT images. One hundred and seventy CBCT scans (69) males and (101) females that used OnDemand3D ® App software were collected from ORASCAN oral and maxillofacial imaging center, Cairo, Egypt. All patients were anonymous. The scans were unrelated to the present study and were collected from a database of images taken for diagnostic purposes or for presurgical evaluation.

Exclusion criteria included the following:

1- More than one mandibular posterior tooth missed per side excluding third molars.
2- Severe periodontal disease.
3- C shaped molar.
4- Fused roots.
5- Resorption of any mandibular tooth.
6- Mixed dentition or deciduous teeth.

CBCT scans will be calibrated by two examiners for radiographic interpretation of the CBCT scans. The examiners were able to change the viewer settings such as contrast, density and sharpness and they were able to magnify the images for better identification and visualization of the measured structures.

Measurement of mandibular canal dimension:

The measurements of mandibular canal included the thickness of buccal and lingual bone adjacent to mandibular canal, bucco-lingual dimension and superior-inferior dimension of the canal.

On the coronal view:

For the first premolar;
The sagittal reference plane was adjusted to be passing along the long axis of the tooth passing by the root apex and the buccal cusp tip.

For the second premolar;
The sagittal reference plane was adjusted to be passing along the long axis of the tooth passing by the root apex and the central fossa.

For the first and second molars;
The sagittal reference plane was adjusted to be passing along the long axis of the root passing by the root apex and dividing the root into two equal halves.

The diameter of the canal was measured vertically along the same adjusted sagittal plane from the upper cortex to the lower cortex. Figure (1)

The horizontal diameter was measured in the middle of the vertical line buccolingually. Along the same horizontal line, the distance from the buccal and lingual cortices to the cortices of the canal were measured. In all measurements the cortical thickness was not included. Figure (2)

Results:

This study was done on total 170 participants, where females represented 101 (59.4 %) of thetotal number, while males

represented 69 (40.6 %) of the total number of participants.

The measurements of Bucco-lingual dimension, superior-inferior dimension of mandibular canal as well as buccal and lingual cortex over the mandibular canal categorized for each tooth type are presented in table (1).

The average bucco-lingual diameter of the canal was measured below each tooth/root. It was the largest below distal root of second molar with an average of (1.98 mm) and the smallest below first premolar with an average of (1.40 mm). The average bucco-lingual diameter of the mandibular canal was (1.79 mm).

By measuring the superior-inferior diameter of the canal, it can be demonstrated that the mandibular canal diameter increase along the course of the canal from the first premolar to the second molar with an average diameter (2.07 mm).

The buccal bone thickness over the mandibular canal was the thickest at the level of the mesial root of second molar with an average of (5.25 mm), and it was the thinnest at the level of first premolar with an average of (1.90 mm).

The lingual bone adjacent to mandibular canal was the thickest at the level of first premolar with an average of (4.96 mm) and it was the thinnest at the level of the distal root of first molar with an average (1.39 mm).

Discussion:

The aim of this study was to determine the dimensions of the mandibular canal and the buccal bone and lingual bone thickness adjacent to it.

CBCT was used to prevent drawbacks associated with panoramic radiographs and periapical radiographs, such as superimposition of anatomical structures and horizontal and vertical magnification.8 Past studies provide some anatomical details but, for the conclusions drawn, the often small sample size may have been a limiting

factor. While the use of CBCT is increasing in dentistry, knowledge can now be collected non-invasively and analyzed in appropriate amounts, as large numbers of scans are used for an accurate description of the mandibular anatomy, resolving the sample size limitation previously seen. CBCT should be considered for presurgical examination of the relation between mandibular canal and teeth apices to give better information more than the conventional radiography. Klinge et al.9 As it enables an accurate reconstruction of the region in a true anatomical representation of 1:1. Sato et al 10. concluded that the anatomical results of cone beam computerized tomography were verified by conducting macroscopic dissection, showing that the main trunks of the lower alveolar artery, vein, and nerve were close to the apex of the second molar. In a study conducted by Kim et.al 4 , the I-CAT Classic CBCT was found to measure distances as accurately as direct anatomic dissection from the apices of the posterior teeth to the mandibular canal. What is beneficial for the clinical relevance and application of this study is that the mandible CBCT studies show a better image quality than the maxilla, possibly because of the greater contrast between the dental alveolus and the cortex that surrounds it. Agbaje et al.11 This results in high quality imaging of the areas of interest.

Awareness of the diameter of the mandibular canal, buccal and lingual bone thickness surrounding the mandibular canal, the relative position of the canal to the teeth apices will help the clinician to prevent nerve injury during apical surgery. Besides, it's important during emergencies where nerve decompression might be necessary to extract previously expressed harmful materials into the mandibular canal that may cause nerve damage.

Regarding the results of this study, there was no significant difference in the mean bucco-lingual diameter and the mean superior-inferior diameter of the mandibular canal compared to a study conducted by Neves et al.12 .

Koivisto et al.13 agreed with the present study that the thickest buccal bone over the mandibular canal was related to mesial root of second molar and the thinnest lingual bone was related to distal root of the first molar. However there was a disagreement between the two studies regarding the average buccal bone thickness; as it was the least at the level of the first premolar (1.9 mm) and the thickness lingual bone was the thickest at the level of first premolar (4.96 mm), while in Koivisto et al. they were related to second premolar.

Conclusion:

Knowledge of the mandibular canal dimensions and thickness of buccal and lingual bone surrounding the mandibular canal is valuable to the surgeon and can provide a basis of information. CBCT is a valuable tool that offers advantages over conventional periapical and panoramic films.

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Table (1) shows measurements of mandibular canal

Tooth/Root	Buccal cortex over mandibularcanal	Lingual cortex over mandibular canal	Mandibular canal diameter	
			Bucco-Lingualdimension	**Superior-Inferior dimension**
1st Premolar MinMax Mean	0.00 5.18 1.90	2.13 8.60 4.96	0.54 2.19 1.40	**0.00** **4.34** **1.77**
2nd Premolar Min Max Mean	0.00 5.30 2.50	0.00 7.48 3.44	0.00 3.63 1.88	**0.00** **3.76** **2.08**
1st Molar mesialroot Min Max Mean	0.85 7.08 4.17	0.00 5.48 1.78	1.00 2.90 1.87	**1.10** **3.99** **2.10**
1st Molar distalroot MinMax Mean	2.74 7.78 5.06	0.00 4.59 1.39	1.01 3.16 1.80	**1.00** **3.38** **2.11**
2nd Molar mesialroot Min Max Mean	0.00 9.34 5.25	0.00 6.23 1.69	0.95 2.93 1.86	**1.03** **3.54** **2.17**
2nd Molar distalroot MinMax Mean	**2.18** **9.42** **5.03**	**0.00** **4.60** **1.59**	**1.13** **3.30** **1.98**	**1.06** **3.74** **2.21**