ORIGINAL ARTICLE

EVALUATION OF INFERIOR DENTAL CANAL VISIBILITY ON CROSS-SECTIONAL CONE-BEAM COMPUTED TOMOGRAPHY (CBCT) IMAGES

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ABSTRACT

Objective: To evaluate visibility of inferior dental canal at various regions of mandible on CBCT cross sectional films.

Methods: This Cross-sectional study was conducted at Department of Oral and Maxillofacial surgery de'Montmorency College of Dentistry/Punjab dental hospital Lahore, March 2023 to January 2024**.** CBCT cross sectional films of 36 cases (72 hemi mandibles) and 108 slices were evaluated by a qualified Oral and Maxillofacial Surgeon and a certified Radiologist. The visibility of IDC was denoted by not visible, partially visible and completely visible.

Results: The IDC was completely visible in 77.7% of the hemi-mandibles. Partially visible were noted in 20.37% of the hemi-mandibles and 1.85% of hemi mandibles IDC was noted not visible. The visibility of the IDC on distal areas of mandible was comparatively clearer than anterior part of mandible. Visibility of IDC was unaffected by presence or absence of teeth.

Conclusion: CBCT provides a quite good source to visualize Inferior Dental Canal in majority of cases. However, IDC is difficult to visualize coming near the mental foramen. Overall CBCT films are satisfactory to visualize IDC in mandible.

Keywords: Cone-beam computed tomography, cross-sectional images, inferior dental canal, mandibular nerve, radiographic assessment, surgical planning

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INTRODUCTION

Procedural operations that involve the mandible, particularly those that include the posterior jaw, will necessitate the identification of the Inferior Dental Canal (IDC) as an essential step in oral and maxillofacial surgery. Secondly, the inferior dental canal, also known as the IDC, is a pair of anatomical structures that can be found in the mandible, beginning with the mandibular foramen and exiting via the mental foramen. Both the right and left sides of the jaw include the inferior dental nerve/inferior alveolar nerve and vessles[1-3]. During implant surgery on edentulous individuals, for instance, when the contents of the IDN may be at risk, it is necessary to determine the precise position of the IDC. Which may be determined by

seeing the distance from the alveolar ridge on the cross-sectional pictures of the CBCT[1,7,20].

There are a number of imaging modalities that have been utilized in the past to ascertain the course of Inferior Dental Canal (IDC), among which intraoral periapical films were the most significant mean[1, 4,5,17], and conventional computed tomography CT. The OPG does not offer an exact measurement of the distance between the alveolar bone crest and the Mandibular Canal, nor does it offer a three-dimensional picture[19,8]. In earlier times, conventional computed tomography (CT) only produced two-dimensional films, which were axial and coronal. Furthermore, the blurring of areas that were not in focus made it impossible to understand the structures that were around the CT pictures.[9,8] A more sophisticated kind of computed tomography known as cone beam computed tomography (CBCT) was developed in modern times. This technique allows for improved results by removing overlaid nearby structures, removing the need for image magnification, reducing radiation doses, and reducing scanning time[6]. These days, CBCT is utilized extensively in dental surgery, as well as oral and maxillofacial surgery[1, 2, 6]. Research demonstrate that the CBCT has an exceptional accuracy when it comes to monitoring the path of IDC[10-12], while other studies provide evidence that the CBCT has limitations when it comes to displaying the development of Mandibular Canal[13,14,18,20]. In some studies It has been demonstrated that cone beam computerized tomography (CBCT) is superior to all other traditional methods of radiography[15].

Variations in cortication makes it difficult to interpret the precise position of the Inferior Dental Canal (IDC) with variations in visualization within the same person[1,2]. The radiographic appearance of the Inferior Dental Canal (IDC) is a radiolucent zone that is surrounded by a superior and inferior border of corticated zone. Thus, this study was aimed to correctly identify the course of IDC in different regions throughout its course.

METHODS

After approval from ethical review board of de'Montmorency College of Dentistry/Punjab Dental Hospital Lahore. The study's sample size of participants was determined using the population adjustment formula for single proportion estimation, considering a 95% confidence level, a precision of 5%, and a power of 0.8, with an expected proportion of 80%.

Data Collection: A total of thirty-six patients CBCT images were evaluated who were presented at outdoor facility of oral and maxillofacial surgery department de 'Montmorency College of Dentistry/Punjab Dental Hospital Lahore, from March 2023 to January 2024 and requiring surgical procedure involving posterior mandible. The sample was composed of 22 females and 14 males.

Inclusion Criteria: Participants had to be dentate, male or female, and at least 18 years old, and were required to have high-quality diagnostic panoramic and CBCT images.

Exclusion Criteria: Patients presenting with history of recent extraction (within 6 months) and those did not provide any written consent were excluded.

CBCT was done by using Planmeca Promax 3D (Planmeca Oy Finland) Voxel Size 0.2mm, exposure cycle 12sec. The software used was Romexis version: 6.2.1.19. Images were acquired perpendicular to occlusal plane of mandible with 0.3mm slice thickness. An experienced Oral and Maxillofacial Surgeon and a Certified Radiologist viewed the slices on 17" screen display and printed on plane film. Total of 108 films were examined for evaluation of mandibular canal (MC) in three regions, first pre-molar region, second molar region and third molar region.

The visibility of MC was denoted as not visible, barely visible, and completely visible. Descriptive statistical analysis was performed on data using SPSS 25.

RESULTS

The visibility of inferior dental canal (IDC) is denoted by completely visible, partially visible and not visible. Completely visible is marked if peripheral cortex of IDC is 80-100% appreciated, likewise partially visible 40-80% and marked not visible if peripheral cortex of IDC is less than 40% on cross sectional CBCT image. Three regions of each 36 patient's 1st premolar 1st molar and 2nd molar region was examined by both surgeon and radiologist. For the first premolar region 21 out of 36 slices/cross sections of CBCT completely visible IDC canal was noted i.e. outer cortex of canal was completely visible.13 slices out of 36 showed most of the part of outer cortex of the canal but not the complete peripheral cortex. In 2 (5.6%) slices very minor or complete absence of IDC cortex was according to the mandibular region noted.

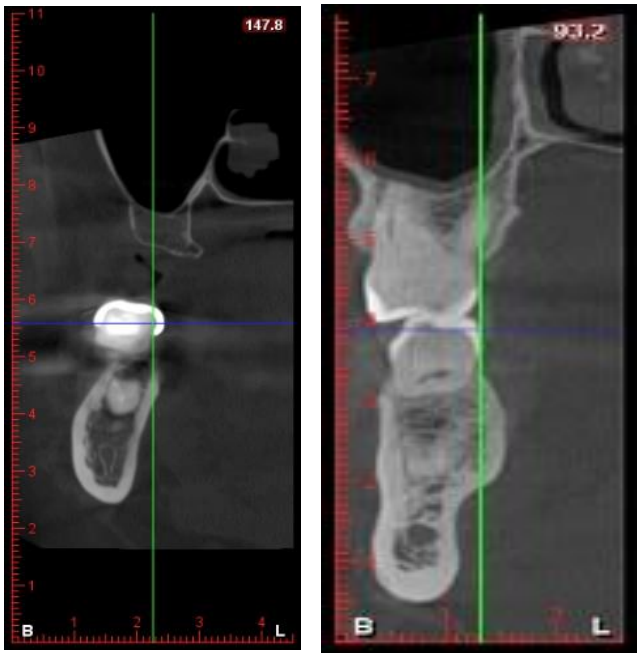
Visibility of IDC on cross sectional CBCT		N	%
First Pre-Molar Region	Not visible	2	5.6%
	Partially Visible	13	36.1%
	Completely visible	21	58.3%
Second Molar Region	Not visible	0	0%
	Partially Visible	6	16.7%
	Completely visible	30	83.3%
Third Molar Region	Not visible	0	0%
	Partially Visible	3	8.3%
	Completely visible	33	91.7%
	Total	**108**	**100%**

Table-1 Percentage of CBCT slices showing positive visibility scores for the Inferior Dental canal (IDC), Similarly for the next region i.e. first molar region none of the slices do not indicate any finding of Inferior

dental canal. 06 (16.7%) showed most of the peripheral cortex of canal.30(83.3%) slices showed completely visible IDC rim. The last portion examined was 3rd molar area where 3 (8.3%) slices showed almost part of outer cortex of IDC, whereas in 33 (91.7%) wholes of the outer cortical rim of inferior dental canal was appreciated. None of the slices in the 3rd molar region failed to show any negative finding of IDC.

DISCUSSION

The fields of dentistry and oral and maxillofacial surgery have been completely transformed as a result of the introduction of new imaging modalities, particularly computed tomography (CBCT). It is feasible to view the complex and extremely dense anatomic structures of the head and neck area without the need of superimposition, which results in reduced radiation exposure,[1,5,6,7] because of this, not only is it possible to visualize, but it is also possible to obtain measurements that are extremely precise using these modalities[2,4,20]. The Dental Canal Under the Lower Jaw There is a possibility that IDC will be apparent in various sections of the mandible over the duration of its course [4,14,19,20].



IDC Canal at 1st Premolar IDC Canal at 1st Molar IDC Canal at 3rd Molar

In his study, DeOliveira-Santos and colleagues noted that CBCT cross-sectional images of the first molar region showed that 59% of the mandibular canal was corticalized or visible. However, in 23% of the cases, the canal was not corticalized or visible, and as a result, it was not possible to appreciate it. This corresponds almost exactly with the findings of our study, which showed that 33.5% of the cases were for the First Pre Molar Region, and it is close to the total results, which were 13.8%.3)The IDC was seen in 53% of the participants in a different research that was carried out by Christiano Oliveira – santos et al., which is extremely similar to the findings of our investigation.["14"]Abbas Shokari and his colleagues carried out a study in which they discovered that the visibility of IDC was 56.3%, which was favorable to our investigation.

The inferior dental canal (IDC) may be seen with a high degree of precision using cross-sectional slices because of the contrast difference between the tissues that are next to it. Through the use of cross-sectional slices of computed tomography (CBCT), it has been demonstrated that cortical and cancellous bone may be evaluated with greater clarity[1,5]. In the current study, the visualization of the inferior dental canal by cross-sectional CBCT pictures was produced by a radiologist and an oral and maxillofacial surgeon who reached a consensus with each other during the process. With regard to the CBCT Slices, it was found that the IDC was extremely simple to understand and interpret. But according to the findings of our research, it was difficult to correctly demarcate the peripheral cortex of the inferior dental canal (IDC) in the majority of the anterior region, specifically the first premolar region, which accounted for 33% (12N) of the CBCT slices, and in the first molar region, which accounted for 8.3% (3n) of the slices. This indicates that the contrast difference in the anterior region is not always easy to appreciate. It has been demonstrated via a number of studies [1,4,9] that Cone Beam CT (CBCT) is superior to the traditional panoramic radiography in terms of its ability to visualize the inferior dental canal. It was made abundantly obvious in the research conducted by Angelopoulous C et al[1] that computed tomography (CBCT) is more effective and superior to traditional panoramic imaging when it comes to seeing the mandibular canal and inferior dental canal. For doctors, the increased visibility of Inferior Dental Canal (IDC) by computed tomography (CBCT) helps in treatment planning, which in turn reduces the likelihood of surgical complications. When it comes to preoperative planning for implant placement and other invasive operations, like as extractions, root canal treatments, and bone grafts near the Inferior Dental Canal (IDC), it has become an extremely helpful tool. In spite of the fact that it has many benefits, CBCT may still have some drawbacks, such as the fact that it is expensive, difficult to obtain, and may result in image distortion due to movement. In addition, in order to guarantee a correct diagnosis and treatment planning, the interpretation of CBCT pictures calls for specialized training and knowledge.

It is encouraging to see those continuous developments in CBCT technology, such as software that assists in the navigation and protection of the Inferior Dental Canal (IDC), has the potential to improve the safety and effectiveness of dental treatments. A further revolution in patient care may be brought about by the combination of Cone Beam CT (CBCT) with digital dentistry techniques, including as computer-aided design and computer-aided manufacturing (CAD/CAM) for implant placement.

STUDY LIMITATION

The radiographic exposure conditions (and, as a consequence, the quality of the result) and, to a certain extent, the examiner's expertise or personal judgment might have an impact on how the visibility level of IDC is reported by the examiner. As the majority of the patients in the public sector are from low-income strata who can't afford scanning. Scarcity of qualified dental radiologists

CONCLUSION

The visibility and identification of the inferior dental canal on cross-sectional CBCT images are critical considerations in dental and maxillofacial surgery. Understanding the factors influencing canal visibility, optimizing image acquisition protocols, and addressing the clinical implications of accurate canal assessment are essential for ensuring safe and effective surgical interventions in the mandibular region. This research article serves as a valuable resource for dental practitioners and radiologists, offering insights to enhance the visualization of the inferior dental canal on CBCT images and improve the accuracy of preoperative assessments in dental and maxillofacial surgery.

CONFLICT OF INTEREST:

Authors declare no conflict of interest.

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ETHICAL APPROVAL

Ethical approval was granted by the Ethical Review Committee of de 'Montmorency College of Dentistry, Lahore vide No 168/DCD dated: 26/02/2023

AUTHOR'S CONTRIBUTIONS

RMM: Conception, design and supervision
AH: Data Collection and critically review
SIM: Manuscript Writing (Initial Draft)
AF: Data analysis and critical review
MMQ: Manuscript writing (Final Draft)
SR: Critical review and interpretation of data
ALL AUTHORS: Approval of the final version of the manuscript to be published

REFERENCES

1. Shokry SM, Alshaib SA, Al Mohaimeed ZZ, Ghanimah F, Altyebe MM, Alenezi MA, et al. Assessment of the Inferior alveolar nerve canal course among saudis by cone beam computed tomography (Pilot Study) *J Maxillofac Oral Surg.* 2019; **18:452**–458. DOI: 10.1007/s12663-018-1167-3
2. do Carmo Oliveira M, Tedesco, T.K., Gimenez, T. Analysis of the frequency of visualization of morphological variations in anatomical bone features in the mandibular interforaminal region through cone-beam computed tomography. Surgical and radiologic anatomy: SRA. 2018;40:1119-1131. DOI: 10.1007/s00276-018-2040-2
3. Razavi S.H, Berahmand S, Sarikhani khorami Kh, Kaboodsaz yazdi M, Namiranian N: The evaluation of mandibular canal visibility on cone beam computed tomography (CBCT) images: A cross-sectional study. Jorjani Biomedicine Journal. 2019; 7(3): 56-67. DOI:10.29252/jorjanibiomedj.7.3.56
4. Akbulut N, Akbulut S, Oztas B. Importance of bifid mandibular canal in implantology and in oral surgery: Review of the literature and report of three cases. Cumhuriyet Dent J 2017; 20:198-203. DOI:10.7126/cumudj.369382
5. Venkatesh E, Elluru S.V. Cone beam computed tomography: basics and applications in dentistry. Journal of Istanbul University Faculty of Dentistry. 2017;51(3 Suppl 1): S102-s121. DOI: 10.17096/jiufd.00289
6. Ishii, H., Tetsumura, A., Nomura, Y.. Diagnostic ability of limited volume cone beam computed tomography with small voxel size in identifying the superior and inferior walls of the mandibular canal. *Int J Implant Dent* **4**, 18 (2018). DOI: 10.1186/s40729-018-0133-7
7. Miles MS, Parks ET, Eckert GJ, Blanchard SB. Comparative evaluation of mandibular canal visibility on cross-sectional cone-beam CT images: a retrospective study. Dento maxillo facial radiology. 2016;45(2):20150296. DOI: 10.1259/dmfr.20150296
8. Kilic C, Kamburoglu K, Ozen T, Balcioglu HA, Kurt B, Kutoglu T, et al. The position of the mandibular canal and histologic feature of the inferior alveolar nerve. Clin Anat 2010; 23: 34–42. DOI: 10.1002/ca.20889
9. Hatcher DC, Dial C, Mayorga C. Cone beam CT for pre-surgical assessment of implant sites. J Calif Dent Assoc 2003; 31: 825–833
10. Tyndall DA, Price JB, Tetradis S, Ganz SD, Hildebolt C, Scarfe WC, et al. Position statement of the American Academy of Oral and Maxillofacial Radiology on selection criteria for the use of radiology in dental implantology with emphasis on cone beam computed tomography. Oral Surg Oral Med Oral Pathol Oral Radiol 2012; 113: 817–826. DOI: 10.1016/j.oooo.2012.03.005

11. assebaum DK, Nummikoski PV, Triplett RG, Langlais RP. Cross sectional radiography for implant site assessment. Oral Surg Oral Med Oral Pathol 1990; 70: 674–678. DOI: 10.1016/0030-4220(90)90421-n
12. Karameh R, Abu-Ta'a MF, Beshtawi KR. Identification of the inferior alveolar canal using cone-beam computed tomography vs. panoramic radiography: a retrospective comparative study. BMC Oral Health. 2023 Jul 4;23(1):445. DOI: 10.1186/s12903-023-03176-8
13. Jameel R, Najm AA, Farhan FA. Visibility of Mandibular Canal on CBCT Cross-Sectional Images in Comparison with Panoramic Radiograph (Retrospective Study) *J Res Med Dent Sci.* 2021; **9:290**–294.
14. Iwanaga J, Katafuchi M, Matsushita Y, Kato T, Horner K, Tubbs RS. Anatomy of the mandibular canal and surrounding structures: Part I: Morphology of the superior wall of the mandibular canal. *Ann Anat.* 2020; **232:151580**. DOI: 10.1016/j.aanat.2020.151580
15. Resha Jameel, Areej Ahmed Najm, Firas Abdulameer Visibility of mandibular canal on CBCT cross-sectional images in comparison with panoramic radiograph (Retrospective study), J Res Med Dent Sci, 2021, 9 (2): 290-294.
16. Hamid MM, Suliman AM. Diameter of the Inferior Alveolar Canal - A Comparative CT and Macroscopic Study of Sudanese Cadaveric Mandibles. *J Evol Med Dent Sci.* 2021; **10:342**–346.
17. Abdulsaheb RJ, Najm AA, Farhan FA. Visibility of Mandibular Canal on CBCT Cross-Sectional Images in Comparison with Panoramic Radiograph: Retrospective Study. International Medical Journal. 2021 Jun 2;28(1):65-68.
18. Oswal RG, Rao KN, Sayed AR, Patil VV. A Comparative Evaluation of Assess Mandibular Canal Visibility in CBCT Images. Annals of the Romanian Society for Cell Biology. 2021;25(1):6237-6243.
19. Abu-Ta'a M, Karameh R, Beshtawi K. Identification of the inferior alveolar canal using cone-beam computed tomography vs. panoramic radiography: a retrospective comparative study. DOI: 10.1186/s12903-023-03176-8
20. Pour DG, Sedaghati A, Shamshiri AR. Effect of resolution and bit depth on inferior alveolar canal visualization on exported mandibular cone-beam computed tomography images. Journal of Oral and Maxillofacial Surgery. 2020 May 1;78(5):731-737. DOI: 10.1016/j.joms.2019.12.022