Journal of Chemical Health Risks

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JCHR (2025) 15(1), 484-491 | ISSN:2251-6727

Assessment of Mandibular Incisive Nerve Canal in Cone Beam Computed Tomography: Cross Sectional Study

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(Received: 16 November 2024 Revised: 20 December 2024 Accepted: 04 January 2025)

KEYWORDS

Mandibular incisive canal, CBCT, Inferior alveolar nerve, Incisive Nerve, Canal identification

ABSTRACT:

Background: The mandibular incisive canal (MIC), an extension of the inferior alveolar nerve, plays a critical role in anterior mandibular anatomy. Its presence and dimensions are essential considerations for surgical procedures such as implant placement, as improper assessment can lead to nerve damage and postoperative complications. Conventional imaging often fails to identify the MIC accurately, necessitating the use of Cone Beam Computed Tomography (CBCT) for precise evaluation.

Aim & Objectives: This study aimed to assess the prevalence, dimensions, and positioning of the mandibular incisive canal using CBCT and to analyze its relationship with anatomical landmarks such as the mental foramen, cortical bone, and alveolar process. The main objective of this study is to measure the distance between the canal and neighbouring anatomical landmarks like mental foramen, cortical bone and alveolar process to avoid the complication, to survey those with and without incisive nerve canal in mandible and to measure the various dimensions of the mandibular incisive nerve canal.

Methods: This cross-sectional study included 330 Indian-origin patients aged 30–50 years. CBCT images were analyzed for MIC presence, dimensions, and proximity to anatomical landmarks. Data were recorded in Microsoft Excel, and statistical analysis was performed using SPSS software, version 23. Descriptive statistics and paired t-tests were used to analyze the data, with a p-value of <0.05 indicating statistical significance.

Results: The MIC was present in 82.2% of the participants (63% unilateral, 19.2% bilateral), while 17.8% lacked the canal. The average canal length for unilateral cases was 8.15 ± 2.46 mm, with a diameter of 2.02 ± 1.13 mm at the origin and 1.37 ± 1.20 mm at the apex. Bilateral canals showed significant differences in length between the right (7.61 ± 2.57 mm) and left (8.94 ± 2.28 mm) sides ($p = 0.003$). Distances from the canal to buccal and lingual cortices varied across samples.

Conclusions: The study highlights the anatomical variability of the MIC and underscores the importance of CBCT imaging for preoperative planning. Accurate identification of the canal's dimensions and positioning can help prevent surgical complications and improve outcomes for anterior mandibular procedures.

1. Introduction

The region between the mental foramen has long been considered safe for the majority of surgical procedures. Radiograph measurements are typically used to place implants in this area since they provide a two-dimensional evaluation. There have been some documented occurrences of perineural damage linked to neurosensory abnormalities brought on by an osteotomy in the anterior mandible; this is due to the existence of mandibular incisive canal. 1, 2 The inferior alveolar nerve, artery, and vein are found in the mandibular canal, also referred to as the inferior alveolar canal (IAC), which is situated inside the internal aspect of the jaw. It commences on the lingual side of the ramus at the mandibular foramen, proceeds along the buccal surface of the mandibular body, and terminates at the mental foramen, which is next to the second mandibular premolar tooth.

The mental nerve, which passes through the anterior part of the jaw and may open lingually at the genial tubercle, is extended medially by the mandibular incisive canal. The nerve can represent multiple morphologies and

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JCHR (2025) 15(1), 484-491 | ISSN:2251-6727

follow a variety of courses. The mandibular incisor nerve is described as the terminal branches of the inferior alveolar nerve that continues its intraosseous pathway into the mandibular anterior region, and provides innervations to the mandibular anterior teeth and canines. 3

An essential factor in anaesthetic technique and surgical planning inside the interforaminal zone which encompasses the mandibular incisors, canines, and first premolars is the existence and placement of the incisive branch of the inferior alveolar nerve (IAN). Due to its ideal bone quality and distance from the IAN compared to the posterior mandible, the interforaminal zone has traditionally been regarded as a safe area for implant implantation and an acceptable donor site for chin block bone grafting. To avoid surgical problems such altered sensation in the anterior teeth, skin, and mucosa, it is still crucial to carefully image the accompanying neurovascular bundles inside the interforaminal zone. Different clinical standards exist about the best location for treatments like implant insertion and bone graft harvesting, despite the therapeutic significance of understanding the position of the neurovascular bundles and related structures inside the interforaminal zone. 4

A radiographic view obtained from dental panoramic tomography is called an orthopantomogram (OPG). In order to evaluate the dentition, periodontal bone support, maxillary and mandibular bony structures, temporo-mandibular joints, and maxillary sinuses, dentists and maxillo-facial surgeons frequently request this view. Orthopantomography has little capacity to identify the mandibular incisive canal. 5

In order to fulfil the demands of cutting-edge technology in the delivery of healthcare, three-dimensional imaging (3D) developed. This evolution also led to the development of new therapeutic approaches. Taking into account the drawbacks of two-dimensional (2D) radiography, which for a long time served as the foundation of diagnostic imaging but has superimpositions, distortions etc.

Cone beam computed tomography (CBCT) allows for an accurate spatial orientation of the nerve anterior to the mental foramen. Due to its affordability, Cone beam computed tomography (CBCT) technology has quickly entered the dental field, but doing so has required a commitment from dental educators and professionals to research the potential uses of this technology. This review's objective is to give readers an understanding of 3D imaging using Cone beam computed tomography (CBCT) technology, including an overview of its fundamental ideas, benefits, drawbacks, and dental applications. With the aid of visualization we can make a diagnosis and can arrange our treatment. 9,10,11,12,13 For the surgery to be successful, a thorough preoperative analysis of the anatomical structures using Cone Beam Computed Tomography (CBCT) is essential. 14, 15

Numerous studies have demonstrated that this exam is the most effective way to get preoperative incisive canal measurements that are accurate and less invasive due to its great anatomic resolution, high degree of repeatability, and reproducibility. 15, 16, 17, 18, 19

The aim of this study was to assess the prevalence of mandibular incisive nerve canal and to evaluate its average location and dimension in patients who have visited karpaga vinayaga institute of dental sciences dental college in Chengalpattu.

2. Materials and Methods

Study Design and Setting

This cross-sectional study was conducted in the Department of Oral Medicine and Radiology. The study was approved by the Institutional Ethical Committee (Institutional Ethical Committee Clearance No: KIDS/IEC/2024/II/023).

Study Population

The Cone Beam Computed Tomography (CBCT) scans of 330 patients both males and females who aged between 30 and 50 years were analyzed. Patients included in the study had been referred for CBCT imaging for various clinical procedures. Inclusion Criteria of this study includes patients aged between 30 and 50 years, patients of Indian origin, and patients referred for CBCT imaging for clinical procedures and exclusion Criteria includes patients not of Indian origin, patients with congenital disorders and syndromic patients.

Data Collection

CBCT scans were taken based on previous study protocols. The total sample size of 330 subjects was

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determined to provide statistically significant data for analysis.

Methodology

Measurement Parameters: The CBCT scan images were analyzed to measure the following:

Distance between the mandibular incisive canal and neighboring anatomical landmarks, such as the mental foramen, cortical bone, and alveolar process, dimensions of the mandibular incisive nerve canal (length, diameter at origin and apex), and distance from the mandibular incisive canal to the inferior border of the mandible.

Figure:1

Image represents length of mandibular incisive nerve canal

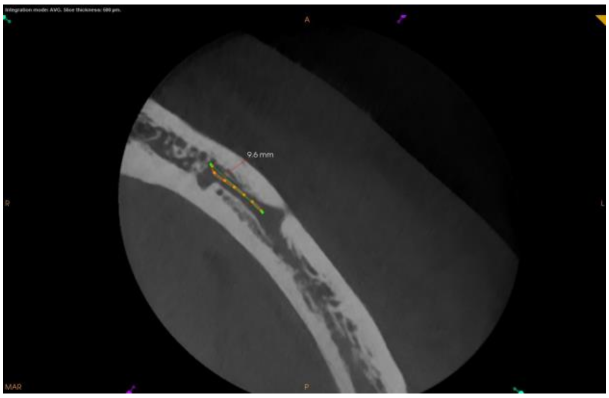


Figure:2

Image represents the length of mandibular incisive nerve canal from origin to base

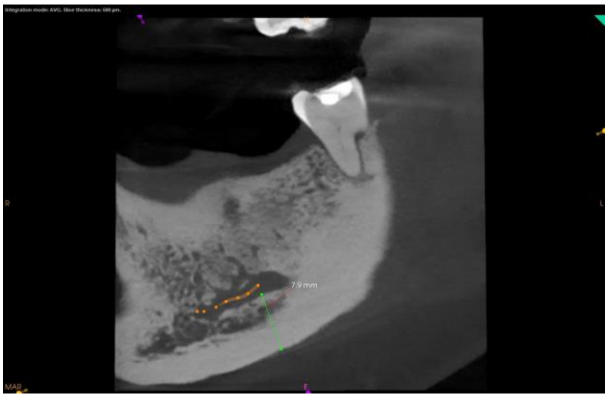
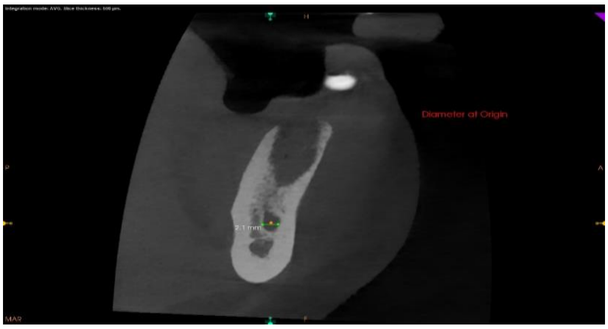


Figure:3

Image represents diameter at origin of mandibular incisive nerve canal



3. Results

CBCT scans were collected and analyzed to measure the dimensions and spatial relations of the MIC, including its proximity to anatomical landmarks such as the mental foramen, buccal and lingual cortical plates, and the alveolar process. Scans were reviewed for both unilateral and bilateral presence of the canal, along with the absence of canals. Measurements such as canal length, diameter at the origin and apex, and distances from the canal to various cortical and alveolar structures were meticulously recorded.

Statistical Analysis

The recorded data were organized and processed using Microsoft Excel, ensuring proper structuring and validation. Statistical analysis was conducted using SPSS (Statistical Package for the Social Sciences) software, version 25. Descriptive statistics, including means and standard deviations, were calculated to summarize the data. Comparative analyses were performed using paired t-tests to identify significant differences between the right and left sides of bilateral canals. A p-value threshold of <0.05 was used to determine statistical significance.

The study revealed that 208 patients (63%) had a unilateral incisive canal, 63 patients (19.2%) had bilateral canals, and 59 patients (17.8%) lacked the canal entirely [Table-1].

Table 1 provides an overview of the presence and distribution of the mandibular incisive nerve canal (MIC) among the 330 participants analyzed in the study. The table categorizes the presence of the canal into three main

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groups: absent, unilateral, and bilateral, and presents the corresponding frequencies and percentages.

The Frequency of absence of mandibular incisive nerve canal is 59 participants out of 330 (17.8% of the total sample) on their CBCT scans. This means nearly 1 in 5 individuals in the study lacked the anatomical feature, signifying a notable variability in mandibular anatomy. A total of 271 participants (82.2%) demonstrated the presence of the mandibular incisive canal. This group was further subdivided into:

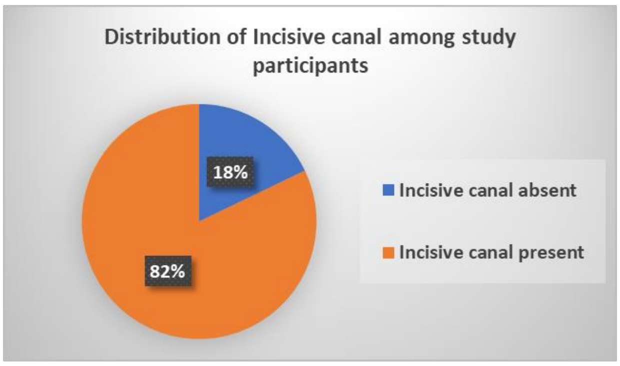
Unilateral Canal: Found in **208 participants (63%)**, where the canal was visible on only one side (either right or left). This indicates that the unilateral configuration is the most common form of canal presence.

Bilateral Canal: Observed in **63 participants (19.2%)**, where the canal was visible on both sides of the mandible. This represents a smaller subset of the population but highlights the anatomical variation.

Table 1 – **Distribution of Incisive canal among study participants**

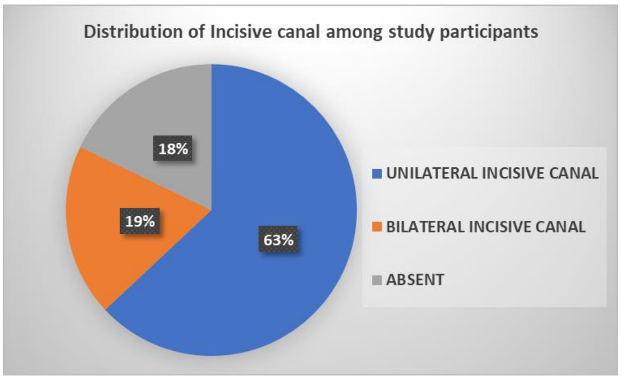
Distribution of Incisive nerve canal	Frequency (Percentage %) Total – 330 (100%)
Incisive canal – Not present	59 (17.8%)
Incisive canal – Present **i)Unilateral Incisive canal** **ii) Bilateral Incisive canal**	271 (82.2%) 208 (63%) 63 (19.2%)

<u>Figure:4</u>



The figure 4 shows 18% of total population with absence of mandibular incisive nerve canal and 82% of the total population with presence of mandibular incisive nerve canal.

<u>Figure:5</u>



The figure 5 shows 18% of the total population with absence of mandibular incisive canal ,19% shows bilateral mandibular incisive nerve canal and 63% shows unilateral incisive nerve canal.

For the unilateral canals, the average length was 8.15 ± 2.46 mm, with a diameter of 2.02 ± 1.13 mm at the origin and 1.37 ± 1.20 mm at the apex. The average distances from the apex to the base and the origin to the base were 8.43 ± 1.41 mm and 8.89 ± 1.55 mm, respectively. The distances to the buccal and lingual cortices varied, with the apex-to-buccal cortex averaging 3.81 ± 1.63 mm and the apex-to-lingual cortex averaging 4.05 ± 1.47 mm [Table-2].

<u>TABLE:2</u>

Descriptive data regarding incisive canal characteristics among unilaterally identified canal participants

S. No	**Characteristics Variable**	**Mean ± SD**	**Standard Error of Mean**
1	Length	8.15 ± 2.46	0.17
2	Diameter of origin	2.02 ± 1.13	0.07
3	Diameter of apex	1.37 ± 1.20	0.08
4	Distance from Apex to base	8.43 ± 1.41	0.09
5	Distance from Origin to base	8.89 ± 1.55	0.10
6	Distance from Apex to buccal cortex	3.81 ± 1.63	0.11

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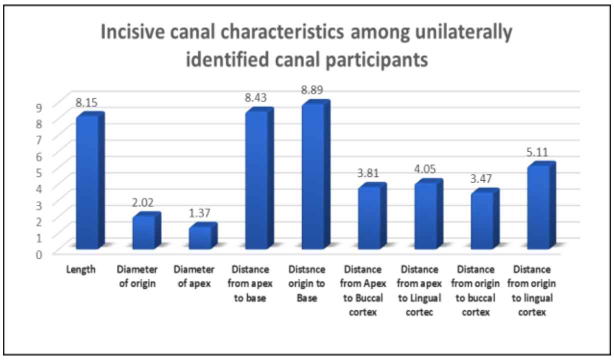
7	Distance from Apex to lingual cortex	4.05 ± 1.47	0.10
8	Distance from Origin to buccal cortex	3.47 ± 2.11	0.14
9	Distance from Origin to lingual cortex	5.11 ± 1.44	0.10

Figure:6



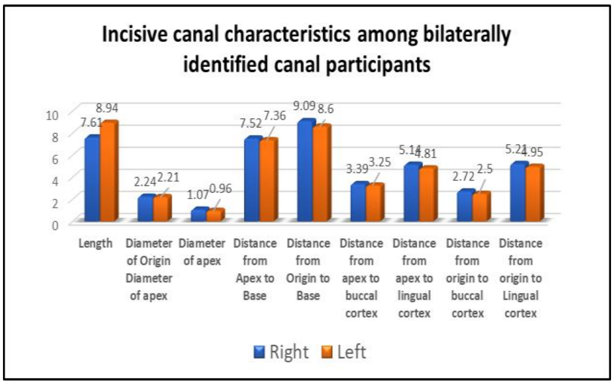
In bilateral canals, the right and left sides showed slight variations. On the right side, the canal length averaged 7.61 ± 2.57 mm, with a diameter of 2.24 ± 0.71 mm at the origin and 1.07 ± 0.31 mm at the apex. On the left side, the average length was 8.94 ± 2.28 mm, with a diameter of 2.21 ± 0.57 mm at the origin and 0.96 ± 0.39 mm at the apex. Distances from the apex to the buccal cortex averaged 3.39 ± 1.15 mm (right) and 3.25 ± 0.91 mm (left). The paired t-test revealed significant differences in canal lengths between the right and left sides (p = 0.003), while other dimensions showed no statistically significant differences [Table-3].

<u>TABLE 3</u> - Descriptive data regarding incisive canal characteristics among bilaterally identified canal participant

	Variable	Mean ± Sd		Sd Error of Mean	T Value	P Value
1.	A	R	7.61 ± 2.57	0.32	-3.06	0.003*
		L	8.94 ± 2.28	0.28		
2.	B	R	2.24 ± 0.71	0.08	0.23	0.810
		L	2.21 ± 0.57	0.07		
3.	C	R	1.07 ± 0.31	0.03	1.78	0.07
		L	0.96 ± 0.39	0.04		
4.	D	R	7.52 ± 2.00	0.25	0.45	0.65
		L	7.36 ± 1.95	0.24		
5.	E	R	9.09 ± 1.60	0.20	1.88	0.06
		L	8.60 ± 1.32	0.16		
6.	F	R	3.39 ± 1.15	0.14	0.75	0.45
		L	3.25 ± 0.91	0.11		
7.	G	R	5.14 ± 1.66	0.21	1.35	0.17
		L	4.81 ± 1.00	0.12		
8.	H	R	2.72 ± 0.75	0.09	1.39	0.16
		L	2.50 ± 1.02	0.12		
9.	I	R	5.21 ± 1.50	0.18	0.97	0.33
		L	4.95 ± 1.41	0.17		

(A-Length of the canal. B-Diameter of origin, C-Diameter of apex, D- Distance from Apex to base, E-Distance from Origin to base, F-Distance from Apex to buccal cortex, G-Distance from Apex to Lingual cortex, H-Distance from Origin to buccal cortex, I- Distance from Origin to lingual cortex, R-Right, L-Left)

Figure:7



4. Discussion

Many people think that the MIC is an anatomical difference in this mandibular region, therefore even though many authors have studied it, there is still a lot of conjecture regarding its presence. This is because traditional radiography methods are unable to detect it20. It is well recognised that the uncertain position and size of these anatomical features frequently impede treatment planning for mandibular surgical treatments. For a number of minor procedures often out in the interforaminal region, such as genioplasty in orthognathic surgery, posttraumatic screw-retained plating, bone harvesting, and endosseous implant insertion, the existence of the MIC is highly relevant21,22,23

The incisive nerve canal can be easily seen by looking at the CBCT pictures in the viewer. It resembles the inferior

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alveolar nerve canal, which is a roughly circular radio-opaque border in a translucent medullary mandibular bone. According to a study by Pires CA et al.,11the superimposition of anatomical features such as the cervical vertebra was the reason why the presence of an incisive nerve was not easily detected by panoramic radiography (11.2%) as opposed to CBCT (88%). Therefore, it seems sense to believe that CBCT study of the mandibular interforaminal region becomes required. According to a study by A S Ramesh et al., the incisive canal was visible in roughly 71.66% of the CBCT scans of the Indian participants that were analysed; of these, 48.33% had bilateral canals and 23.33% had unilateral canals. The CBCT scans of 28.33% of the individuals showed no signs of an incisive nerve canal24

The study done by us shows 208 patients that is 63% of the population has unilateral incisive nerve canal and 63 patients that is 19.2% has bilateral incisive nerve canal. The data also shows 59 patients that is 17.8% has no incisive nerve canal. The maximum length of mandibular incisive nerve canal in unilateral data is 8.15 2.46 and in bilateral data it is 7.61 2.57 in right side and 8.94 2.28 in left side.In unilateral data the distance from apex to buccal cortex is 3.81mm and from origin to buccal cortex 3.47mm and the distance from apex to lingual cortex is 4.05 and the distance from origin to lingual cortex is 5.11mm.In bilateral data the average distance from apex to buccal cortex at right is 3.39mm and at left is 3.25mm and the average distance from origin to buccal cortex is 2.72mm at right and 2.50mm at left.

Understanding the incisive canal's path is just as crucial as understanding the mandibular inferior alveolar nerve canals, since it may result in nerve damage, postoperative myalgia, and other nerve-related issues.

5. Conclusions

Oral radiologists will be able to safely plan and navigate the interforaminal region and surgeons will also be able to prevent neurosensory problems by mapping the incisive nerve canal. In order to ascertain the proper site of MIC, it is recommended that treatment planning be done on an individual basis via a 3D imaging modalities. As more patients are choosing prosthodontic treatment, which involves implant placement, the idea of "All on Four" and related therapy approaches have become more well-known in recent years. The anterior mandible is one of the most straightforward and appropriate sites for implant placement, because there were fewer implants in the anterior mandible in the past, there were fewer reported complications. However, as the number of implants has increased recently, so have the chances of complications. As a result, as the use of implants in this area has increased, our understanding of its anatomy must be improved.

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