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RESEARCH ARTICLE

PREVALENCE, DIAMETER AND FURRING OF MANDIBULAR INCISIVE CANAL IN NORTH INDIAN SUBPOPULATION: A CBCT STUDY

Dr. Smriti Rohilla[1], Dr. Shabnam Negi[2], Dr. Sameer Makkar[3], Dr. Nisha Garg[4], Dr. Sandeep Gupta[5] and Dr. Jyotsana Sikri[6]

1. Post Graduate Student, Departmentof Conservative Dentistry and Endodontics Bhojia Dental College and Hospital, Baddi, Himachal Pradesh, India.
2. Reader, Departmentof Conservative Dentistry and Endodontics Bhojia Dental College and Hospital, Baddi, Himachal Pradesh, India.
3. Professor and Head, Department of Conservative Dentistry and Endodontics Bhojia Dental College and Hospital, Baddi, Himachal Pradesh, India.
4. Professor, Department of Conservative Dentistry and Endodontics, Bhojia Dental College and Hospital, Baddi, Himachal Pradesh, India.
5. Reader, Department of Conservative Dentistry and Endodontics Bhojia Dental College and Hospital, Baddi, Himachal Pradesh, India.
6. Reader, Department of Conservative Dentistry and Endodontics Bhojia Dental College and Hospital, Baddi, Himachal Pradesh, India.

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Abstract

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Objective: The Mandibular Incisive Canal (MIC) carries mandibular neurovascular bundle and it is necessary to determine the presence of MIC & its relation to adjacent anatomical landmarks to avoid any potential damage to neurovascular bundle during various surgical procedures. So, this study was planned to determine the prevalence, canal diameter and its relation with adjacent anatomic structures using CBCT and to find their associations with age, gender and laterality.
Methods: CBCT scans of 61 patients (33 M, 28 F) were evaluated in sagittal sections.
Results: The overall prevalence of MIC on the right side was found to be 65.6% while it was 73.8% on the left side. The MIC was more prevalent in females as compared to males between the 30-50 years of age. The mean diameter on the right and left side was found to be 0.85 ± 0.25 mm & 0.93 ± 0.27 mm respectively. The mean distance of MIC from buccal cortex was (3.5 ± 1.3 & 3.6 ± 1.8 mm), lingual cortex (4.8 ± 1.6 & 4.8± 2.0 mm) & inferior border of the mandible (10.1 ± 3.7 &10.4 ± 3.3 mm) on right and left side respectively.
Conclusions: The preoperative assessment of CBCT is advocated especially in middle age, females and left side for MIC evaluation &the findings of this study will help in identifying safe area during surgical procedures in inter-foraminal region. Periapical surgery, implants, genioplasty etc. can be planned in a better manner by avoiding potential danger areas.

Corresponding Author:- Dr. Shabnam Negi
Address**:-** Reader, Departmentof Conservative Dentistry and Endodontics, Bhojia Dental College and Hospital, Baddi, Himachal Pradesh, India.

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Introduction:-

The Anterior Mandibular Area is generally regarded as a safe place for surgical interventions due to the perceived lack of localization and its thickbuccal & lingual cortical plates and a denser bone marrow. The anterior mandible is often used to harvest automatic bone grafting, implant, endodontic periapical surgery, rehabilitation after traumatic injury etc [1]. The three anatomic structures of concern present in this area include Mandibular Incisive Canal (MIC), Sublingual Artery (SLA), and Submental Artery (SMA) [2].

The MIC is a bony canal within the anterior mandible that usually runs bilaterally from the mental foramen to the region of the ipsilateral lateral incisor tooth. The Inferior Alveolar Nerve travels in the bony mandibular canal and it branches into mental nerve that exits from mental foramen. The Inferior Alveolar Nerve continues anteriorly within the mandibular incisive canal as the mandibular incisive nerve, providing innervations to the mandibular first premolar, canine and lateral& central incisors and surrounding soft tissues [3,4] The mandibular incisive nerve either ends as nerve endings within the mandibular anterior teeth or adjacent bone or may join nerve endings that enter through a small lingual foramen.As an extension of the inferior alveolar canal, the MIC should be given equal importance as it carries a neurovascular bundle and careful preoperative planning should be done for surgical procedures as any sort of trauma or insult to neurovascular bundle can lead to neuropathy orlife-threatening bleeding in its vicinity. Despite being considered the interforaminal region being a 'safer & predictable zone', few case reports have described complications following surgery in the anterior mandible such as postoperative neural disturbances, lack of osseointegration of implants, pulp sensitivity changes, edema, and neuropathic pain due to perforation of mandibular incisive canal [5,6]. Therefore, the risk of damaging the important anatomic structures should not be overlooked.

Cone Beam Computed Tomography (CBCT) has gained much popularity in the recent years as it can display anatomical structures in three dimensions without superimposition and blurring that is seen in conventional 2D imaging such as periapical and panography radiography. Also, it has multiplanar views & 3D reconstruction in addition to reformatted images and with uniform magnification. Hence, several researchers have advocated for the use of CBCT for studying MIC & related landmarks and obtaining presurgical mandibular incisive canal measurements.Earlier, it was believed that the mandibular incisive nerve runs through the intramedullary spaces, and not within a bony canal, therefore, was not commonly detected by conventional radiography [7].However, with the emergence of newer imaging techniques such as smaller voxel sized CBCT, several anatomic challenges have been identified by clinicians. Furthermore, anatomical studies using advanced imaging have shown strong evidence supporting the existence of the MIC.

The literature showed the overall prevalence of MIC ranged between 36.3 - 98% [8-19]. The mean canal diameter ranged between 0.93 - 3.1mm [20,21]. The distances from buccal, lingual and inferior border of the mandible were found to be 1.78- 5.89 mm [22,23],3.63- 6.63 mm [22,23]and 7.00-10.25 mm [22,5]respectively. The prevalence, diameter, and length of MIC have been extensively studied by researchers but there is paucity in literature regarding furring (surrounding bone) of MIC and their corelation with age. So, this study was planned with the primary objective to determine the prevalence, measure the canal diameter and its relation with adjacent anatomic structures using CBCT. The secondary goal wasto find their associations with age, gender and laterality. This research might serve as a reference for the localization of this structure during surgeries in the region between the mental foramen inpatients.

Material and Methods:-

Study Design:

Retrospective Cross-sectional Study.

The currentstudy was carried out in the Department of Conservative Dentistry & Endodontics in BDC.The study sample included CBCT scans of 61 patients who were previously subjected to CBCT scans at a single private diagnostic centre with for valid reasons. Out of 61 patients, 33 were males and 28were females. The age of patients who were considered for the study was 10-70 years.

The total sample was categorised into 3 age groups:

1. Age Group - 1 (AG1) consisted of patients from 10 to 30 years of age.

2. Age Group - 2 (AG2) consisted of patients in age range of 31 to 50 years.
3. Age Group- 3 (AG3) consisted of patients of age between 51 to 70 years of age.

Inclusion criteria for the study were:
1. Dentate or edentulous patients.
2. Images of the interforaminal region of the mandible in multiplanes.

Exclusion criteria were as follows:
1. Congenital disorders or Syndromic patients.
2. Any history of trauma, pathology to the mandible or surgical intervention in the interforaminal region.
3. Distorted images in CBCT.

CBCT Imaging Method

Acteon 3D X-MIND TRIUM CBCT machine was used for this study.It had a tube voltage of 85 kVp; tube current of 8 mA; isotropic voxel size of 1.5 mm & exposure time of10-14 seconds. All the scans were done by the same technologist, following a standardized protocol for patient positioning and exposure parameter settings.

Images were examined using the scanner's exclusive software **Acteon Imaging Suite**which allowed for linear measurementsin PC Work station **DESKTOP-V29LIHM Inspiron 7415 2-in-1** (AMD Ryzen 5 5500U with Radeon Graphics 2.10GHz processor) running Windows 11 Home Single Language (Microsoft Corp, Redmond, WA, USA). The level of the images was adjusted using the image processing tool in the software to ensure optimal visualization.

Image selection &analysis

Initially the presence of MIC was traced after reconstruction of the images in multiplane views (Axial, cross-sectional & Sagittal sections) and then the measurements were made using the tool in **Acteon Imaging Suite**. The MIC is presented as a radiolucent area surrounded by radiopaque rim (Fig. 1a). The presence of MIC was assessed only in sagittal sections and only if MIC was definitely visible. The followingmeasurements were made on sagittal sections, corresponding to maximum diameter of MIC.

1. The diameter of the canal at its maximum circumference in the sagittal sections (Fig. 1b).
2. Furring included distances of MIC from:
    i. Buccal cortex.
    ii. Lingual cortex.
    iii. Inferior border of the mandible (Fig.1c).

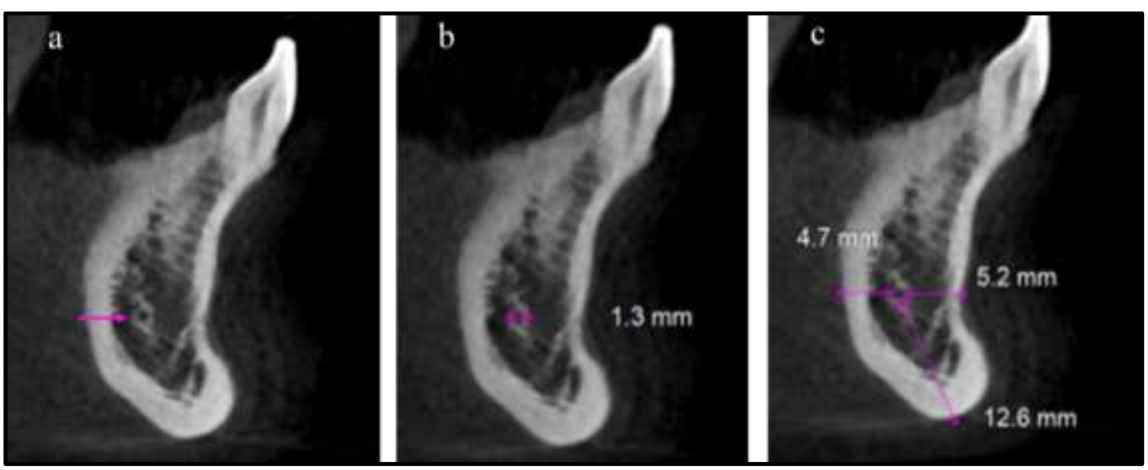

Fig. 1:- Presence of MIC & its Measurements.

All the measurements were done by the same examiner after standardization and the values were inserted in MS-Excel file.10 % sample was repeated for all the measurement. Intra-examiner reliability was found excellent with correlation coefficient of 0.972.

Statistical Analysis:
All the findings were noted down in specially designed proforma. The data was entered in MS-Excel sheet and was analysed using SPSS Statistics Software v22.0 (IBM Corporation, New York, NY, USA) using statistical tests such as Kendalls Tau & Chi square. Categorical variables like age &genderwas presented as numbers and its percentages.

Results: -

The total sample consisted of 61 patients (33: Males & 28: Females). The overall prevalence of MIC on the right in the studied sample was found to be 65.6% (n=40) while it was 73.8% (n=45) on the left side. Forty-nine patients (80.3%) had MIC either on both or one side. An increased prevalence was seen on the left side as compared to right side. Out of 33 male patients 23 (69.6%) had MIC on right side while 22 (66.6%) had MIC on left side. Similarly, out of 28 female patients, 17 (60.7%) had MIC on right side while 23(82.1%) had MIC on left side. (Table 1).

	N	Right		Left	
		n	Percentage	n	Percentage
Male	33	23	69.6%	22	66.6%
Female	28	17	60.7%	23	82.1%
Total	61	40	65.6%	45	73.8%

Table 1:- Overall Prevalence of MIC according to Gender.

The prevalence in various age groups is described in Table 2. In AG1(n=21), the prevalence of MIC on right side was found to be 57.1% while it was 71.4% on left side. In AG2 (n=25), the prevalence of MIC was found to be 76% on right side while it was 80% on left side. In AG3 (n=15), the prevalence was found to be 60% on right side while it was 66.7% on left side.

	Age Group-1 (10 – 30 years) (n=21)	Age Group-2 (31 – 50 years) (n=25)	Age Group- 3 (51 – 70 years) (n=15)	Total (N=61)
Right	57.1% (n=12)	76% (n=19)	60% (n=9)	65.6% (n=40)
Left	71.4% (n=15)	80% (n=20)	66.7% (n=10)	73.8% (n=45)

Table 2:- Prevalence in different age groups.

The maximum and minimum canal diameter that was found on the right side was 1.40mm and 0.40mm with a mean± SD of 0.85±0.25mm. Similarly, the maximum and minimum canal diameter that was found on the left side was 1.50mm and 0.50mm with a mean± SD of 0.93±0.27 mm (Table 3).

	N	Maximum Diameter	Minimum Diameter	Mean ± SD
Right	40	1.40	0.40	0.85 ± 0.25
Left	45	1.50	0.50	0.93 ± 0.27

Table 3:- Comparison of Maximum & Minimum diameter of MIC on Right & Left side (in mm).

The mean distance between MIC & buccal cortex was 3.5±1.3mm on right side while it was 3.6± 1.8 mm on left side. The mean distance between MIC & lingual cortex was 4.8±1.6mm on right side while it was 4.8±2.0 mm on left side. The mean distance between MIC & inferior border of the mandible was 10.1±3.7 mm on right side while it was 10.4±3.3mm on left side (Table 4).

	N	Distance Between MIC & Buccal cortex			Distance Between MIC & Lingual cortex			Distance Between MIC & Inferior border of Mandible		
		Maximum	Minimum	Mean ± SD	Maximum	Minimum	Mean ± SD	Maximum	Minimum	Mean ± SD
Right	40	6.4	0.9	3.5 ± 1.3	7.8	1.6	4.8 ± 1.6	17.7	4.4	10.1 ± 3.7
Left	45	8.6	0.7	3.6 ±	11.3	1.4	4.8 ±	17.6	5.3	10.4

				1.8			2.0			± 3.3

Table 4:- Comparison of distance between MIC and Buccal cortex, Lingual Cortex & Inferior Border of Mandible on Right and Left side (in mm).

The mean canal diameter on right side in AG1, AG2, AG3 was1.11±0.16 mm, 0.83±0.14 mm& 0.52±0.08mm respectively (Table 5). The difference between AG1 & AG2, AG1&AG3 and AG2 & AG3 was found to be 0.27, 0.59 & 0.31 respectively which were statistically significant. The mean canal diameter on Left side in AG1, AG2, AG3 was 1.18±0.16 mm, 0.86±0.16 mm& 0.72±0.32 mm respectively and the difference between AG1 & AG2 and AG1& AG3 was found to be 0.32 & 0.46 respectively which were statistically significant. The difference between AG2 & AG3 was found to be 0.14, which was statistically non-significant. The Pearson correlation coefficient for age and canal diameter on right and left side were -.861 & -.661. The distance between MIC & Buccal cortex was not related to age of patients on right side and left side. The distance between MIC & Lingual cortex on right side decreased with increase in age while it increased with age on left side. But the changes were not statistically significant. The distance between MIC & Inferior border of the mandible on the right side decreased with increasing age but the changes were statistically non-significant. The distance between MIC & Inferior border of the mandible on the left side decreased from AG1 to AG2 and then it increased from AG2 to AG3 but changes were statistically non-significant.

	Mean Value ± SD			**AG1 - AG2**		**AG1 - AG3**		**AG2 - AG3**	
	AG 1	**AG 2**	**AG 3**	**Mean difference**	**P value**	**Mean difference**	**P value**	**Mean difference**	**P value**
Right Canal Diameter	1.11 ± 0.16	0.83 ± 0.14	0.52 ± 0.08	0.27	.000	0.59	.000	0.31	.000
Left Canal diameter	1.18 ± 0.16	0.86 ± 0.16	0.72 ± 0.32	0.32	.000	0.46	.000	0.14	.082
Right Distance Between MIC & Buccal cortex	3.95 ± 1.05	3.01 ± 1.23	4.03 ± 1.50	0.93	.145	-.08	1.000	-1.0	0.15
Left Distance Between MIC & Buccal cortex	3.66 ± 2.02	3.62 ± 1.64	3.70 ± 2.17	0.04	1.000	-.04	1.000	-.08	1.000
Right Distance Between MIC & Lingual cortex	5.27 ± 1.81	4.96 ± 1.63	4.20 ± 1.36	0.30	1.000	1.07	.437	0.76	.763
Left Distance Between MIC & Lingual cortex	4.82 ± 1.97	4.85 ± 1.62	4.99 ± 2.83	-.03	1.000	-.17	1.000	-.13	1.000
Right Distance Between MIC & Inferior border of Mandible	10.34 ± 3.61	10.08 ± 3.94	9.83 ± 3.78	.25	1.000	.50	1.000	0.25	1.000
Left Distance Between MIC & Inferior border of Mandible	10.13 ± 3.00	9.72 ± 3.31	12.34 ± 3.48	0.40	1.000	-2.21	.307	-2.62	.130

Table 5:- Changes in MIC Morphometric Parameters with respect to Age (in mm).

Discussion:-

In the present study, MIC was identified in the reformatted images in sagittalsections of CBCT scans as a round radiolucent area within the mandibular trabecular bonesurrounded by a radiopaque rim. The prevalence of 65.6% & 73.8% on right and left side respectively in the present study. Borghesi et al [11]found prevalence rate of 82.3% in premolar region of 222 dentate hemi-mandibles.Ayesha RT et al [8]found prevalence of MIC on right and left side as 36.3% and 40 % respectively. Zhang et al [14] found 92.8 % prevalence in CBCTs of 1070 hemimandibles. Avvaru et al [19] found MIC in 98% of CBCT images. Sener et al [10] found 80% of prevalence rate in dentate patients in a sample of 35 patients. Kabak et al [13]in 100 CBCT scans found prevalence rate of 92%. Yang et al [17] found 97.33 % prevalence in 824 CBCT scans. Sahman et al [16] reported that the MIC was visible in 94.4% CBCT images. Apostolakis and Brown [15] identified the MIC in 93% of the cases. Huang et al [9] found 78.75% prevalence in 80 patients. Sokhn et al [18] identified the MIC in 97.5% of the images. There was 91% visualization of the MIC in a study done by Makris et al [12].

The difference in prevalence could be attributed to sample size, age, ethnicity, CBCT machine, voxel size, processing software and method of evaluation. Our study indicated a slight increased prevalence towards the left side and a higher prevalence was seen in females as compared to males in a gender wise comparison. The difference may be attributed to the variability in initiation of ossification, visibility of the MICin CBCT images due to variable bone density and pattern of osseous remodelling by variable occlusal forces in two genders.

In our study among the different age groups, highest prevalence (76% R &80% L) was seen in age group 2 that included sample between 31 to 50 years of age. Ayesha RT et al [8] found prevalence of 44% (31-40 years), 41.7 % (41-50 years). We found prevalence of 57.1% on right side & 71.4% on left side in age group 10-30 years. Ayesha RT et al [8] found prevalence of 38.2% (20-30 years). We found prevalence of 60% on right side & 66.7% on left side in age group above >50 years while Ayesha RT et al [8] found prevalence of 66.7% (>50 years). This difference may be due to different methodology and ethnicity. Variable prevalence at different age groups may be due to age related osseous remodelling and mineral content of the bone which may affect the visibility of the MIC in CBCT images.

The diameter of the MIC is another irrefragableelement to be considered for presurgical planning of procedures in anterior mandible. In our study, the maximum and minimum canal diameter on the right side was found to be 1.40mm and 0.40mm respectively with a mean value of 0.85±0.25 mm. Similarly, the maximum and minimum canal diameter on the left side was 1.50mm and 0.50 mm respectively with a mean value of 0.93±0.27 mm. Barbosa et al [20] measured horizontal diameter at initial and end point as 1.78± 0.41mm and 1.00 ± 0.35mm. Similarly, they recorded vertical diameter at initial and end point as 1.93 ± 0.40 mm and 0.93 ± 0.27 mm. Zhang et al [14] found mean diameter of 2.5 ± 0.5 mm at origin of MIC. Avvaru et al [19] recorded the mean diameter of MIC at its origin as 1.6 ± 0.4 mm & 1.8 ± 0.5 mm on right and left side respectively. The difference between right and left were not significant. Sener et al [10] in a sample of 35 patients found MIC mean diameter 2.44 ± 0.702 mm. Kong et al [24] in sample of 50 patients found canal diameter in the range of 0.9 - 2.22 mm on left side and 0.87 - 2.14mm on right side. According to Sahman et al [16] the mean diameter of the MICs was 1.91 ± 0.45 mm on the right side and 1.94 ± 0.41 mm on the left side. This discordance may be attributed to ethnicity, age and CBCT machine. Huang et al [9] found mean diameter of 1.2 ± 0.29 mm. Parnia et al [25] evaluated the diameters in CBCT images of 96 patients and reported that the mean diameters of the right and left canals were 1.49 ± 0.70 mm and 1.44 ± 0.48 mm, respectively and these findings corresponds to our study as well. Uchida et al [26] in 142 hemimandibles found average diameter of 2.8mm (1 - 6.6mm). Pires et al [27]in 178 hemimandibles found diameter in the range of 0.4 - 4.6mm. Uchida et al [21] in anatomical study found mean diameter at origin was 3.1mm (1-6.6 mm) and at 5mm average diameter was 1.7mm (0.5 – 4.9 mm). Jacobs et al [1]in a radiographic study found diameter of inner contour as 1.1mm (0.5-2.3mm). Mardinger et al [28]in 46 hemimandibles reported mean diameter of 1.2mm (0.48-2.9mm). Bavitz et al [29] found mean diameter in mental nerve region reported mean diameter of 1.3mm (0.5-2mm) in dentate patients while mean diameter of 1.3mm (0.5-2mm) in edentulous patients. In our study the canal diameter on the left side was found to be greater as compared to right side. This may be due to unilateral chewing habit that may lead to differential occlusal forces resulting in variable bone remodelling.

The mean distance of MIC from buccal cortex was 3.5±1.3mm on right side while it was 3.6±1.8mm on left side. Ayesha RT et al [8] recorded the distance of MIC from labial surface as 4.3 ± 1.4 mm. Barbosa et al [20] found average distance of MIC to buccal cortex at initial and end point as 2.60 ± 1.27mm and 3.96 ± 1.43 mm. Lim et al [23] in a sample of 100 CBCT scans found a mean distance of MIC from buccal cortical plate as 3.76 ± 1.1 mm, 5.54 ± 1.58 mm &5.89 ± 1.70 mm at starting point, middle point & end point respectively. Our findings were in accordance to the findings of Zhang et al [14] reported distance of MIC from buccal cortex as 3.7 ± 0.9 mm. Avvaru et al [19] noted the mean distance from buccal cortex at origin as 4.1 ± 1.3 mm & 4.2 ± 1.1 mm on right and left side respectively. They found the mean distance from buccal cortex at apex as 4.6 ± 1.1 mm & 4.8 ± 1.4 mm on right and left side respectively. The differences on right and left side at origin and apex were not significant statistically. Marinho et al [22] noted the mean distance from buccal cortex at origin as 1.78± 0.90 mm and 1.89 ± 0.86 mm on right and left side respectively, and at end point of MIC as 2.39 ± 0.99 mm & 2.68 ± 1.46 mm on right and left side respectively. Pereira-Maciel P et al [5] found mean distance of MIC from buccal cortical plate as 4.62 ± 1.37 mm. Huang et al [9] reported distance of MIC from buccal cortex as 3.8 ± 1.37 mm. Apostolakis and Brown et al [15] recorded the mean distance from buccal cortex as 2.8 mm (0.6-7.2mm) in premolar region, 4.4 mm (0.9-8.7 mm) in canine region & 4.8 mm (0.9-8.2mm) in incisor region.

The mean distance between MIC & lingual cortex was 4.8±1.6mm on right side while it was 4.8±2.0mm on left side. Ayesha RT et al [8] recorded the distance of MIC from lingual surface as 4.34 ± 1.53 mm. Barbosa et al [20] found average distance of MIC to lingual cortex at initial and end point as 5.13± 1.70 mm and 4.61 ± 1.65 mm respectively. Lim et al [23]in a sample of 100 CBCT scans found a mean distance of MIC from lingual cortical plate as 6.63 ± 1.51 mm, 5.07 ± 1.41 mm & 4.72 ± 1.61 mm at starting point, middle point & end point respectively. Our findings were not very much deviated from the findings of Zhang et al [14] reported distance of MIC from lingual cortex as 5.1 ± 1.6 mm. Avvaru et al [19] noted the mean distance from lingual cortex at origin as 4.2 ± 1.01 mm & 4.01 ± 1.02 mm on right and left side respectively. The differences on right and left side were not significant at origin. Marinho et al [22] noted the mean distance from lingual cortex at origin as 3.87 ± 1.53 mm and 3.65 ± 1.49 mm on right and left side respectively, and at end point of MIC as 3.81 ± 3.63 mm & 3.63 ± 1.49 mm on right and left side respectively.Pereira-Maciel P et al [5] found mean distance of MIC from lingual cortical plate as 6.25± 2.03mm. Huang et al [9]who reported distance of MIC from lingual cortex as4.45 ± 1.34mm. Apostolakis & Brown et al [15] recorded the mean distance from lingual cortex as 5.3 mm (1.2-10.8 mm) in premolar region, 4.6 mm (0.6-9.6 mm) in canine region & 5.7 mm (1.5-9.3 mm) in incisor region.

The minor difference of distances of MIC from buccal and lingual cortex in our study could be due to selection of sagittal sections for evaluation of MIC. Few authors have evaluated MIC at initial and end point while we have selected the maximum visible diameter of MIC as it will give the true identification or risk of potential damage to neurovascular bundle during surgical interventions in interforaminal region.

The mean distance between MIC & inferior border of the mandible was 10.1±3.7 mm on right side while it was 10.4±3.3mm on left side. Ayesha RT et al [9] recorded the distance of MIC from lower border of mandible as 9.41 ± 1.83 mm. Barbosa et al [20] found average distance of MIC to border of the mandible at initial and end point as 9.32 ± 1.92 mm and 8.76 ± 2.07 mm respectively. Zhang et al [14] reported distance of MIC from inferior border as 8.9 ± 1.7 mm. Avvaru et al [19] noted the mean distance from inferior border of the mandible at origin as 8.7 ± 2.8 mm & 9.1 ± 2.1 mm on right and left side respectively. They found the mean distance from inferior border of the mandible at apex as 8.8 ± 2.1 mm & 8.8 ± 1.8 mm on right and left side respectively. The differences on right and left side at both origin and apex were not statistically significant. Marinho et al [22] noted the mean distance from mandibular base at origin as 7.52 ± 1.67 mm and 7.53 ± 1.81 mm on right and left side respectively, and at end point of MIC as 7.00 ± 1.98 mm & 6.87 ± 2.34 mm on right and left side respectively. Pereira-Maciel P et al [5] found mean distance of MIC from inferior border of the mandible as 10.25 ± 2. 27mm.Huang et al [9] reported distance of MIC from inferior border as 7.82 ± 1.87 mm. The discordant findings could be due to different ethnicity or method of evaluation. Apostolakis & Brown et al [15] recorded the mean distance from inferior border of the mandible as 9.9 mm (3.9-14.4 mm) in premolar region, 7.9 mm (3.3-12.3 mm) in canine region &8.1 mm (5.1-14.1 mm) in incisor region.

The distance of MIC from inferior border of the mandible was more as compared to that from lingual and buccal cortical plate. Also, the distance of MIC from buccal and lingual cortical plate was found to be more on left side, while the distance of MIC from inferior border of the mandible was more on right side. Our finding corresponds to the study conducted by Pereira-Maciel et al [5], Apostolakis&Brown [15] and Rosa et al [30] who also found MIC to be closer to the buccal cortical plate.

The mean difference between canal diameter on right side between AG1 - AG2, AG2- AG3 & AG1- AG3 were 0.27 (P=0.000), 0.31(P=0.000) & 0.50 (P=0.000) respectively showed the mean canal diameter on right side was smaller in older age groups and the difference was statistically significant. Similarly, the mean difference between canal diameter on left side between AG1-AG2, & AG1-AG3 were 0.32 (P=0.000) & 0.46 (P=0.000) respectively showed the mean canal diameter on left side was smaller in older age groups and the difference was statistically significant. The mean difference between canal diameter on left side between AG2-AG3 was 0.14 (P= 0.082) which showed smaller diameter in older age group and the difference was statistically non-significant. The decrease in diameter with increased age could be due to selective bone deposition in and around MIC.Lim et al [23] measured horizontal distances from MIC to buccal and lingual cortex in different age groups (18-38 years, 39-59 years, 60-80 years) and showed no statistical difference in between any age groups on both right and left side.

The mean values of canal diameter in different age groups suggests that there are some age-related changes or with increase in age there is decrease in canal diameter due to continuous bone remodeling due to occlusal forces. Also, our study suggests that there is rapid decrease in canal diameter up to the age of 50 years. The decrease in canal diameter after 50 years is slow as compared to that below 50 years. Accelerated bone demineralisation especially in post-menopausal females could be a possible factor in slower bone deposition in and around MIC. The Pearson correlation coefficient for age and canal diameter on right and left side were -.861 & -.661which suggests there was strong correlation between these two factors. It appears that canal diameter decreases with increase in age.

Nerve injuries with altered sensations following endodontic surgical procedures represent a rare but serious complication, and the classification of those injuries is based on their time course and on the potential sensory recovery following the injury. Bilginaylar K et al [31] reported a case in which the patient complained of pain at the left premolar region of the mandible & a tingling sensation on the left lower lip, and the authors found MIC in relation with cystic cavity of the canine tooth and extracted socket of first premolar tooth. Careful attention should be paid to the positioning and presence of the MIC and incisive canal in relation to identification and treatment of anterior mandibular and periapical pathology.

Direct trauma to the nerve bundle during surgery can cause nerve injury and may lead to long-term disability and to significant negative effects on the patient’s quality of life. The high rate of postoperative sensory disturbances and loss of tooth vitality after bone harvesting from the mandibular symphysis can be explained by the possible damage to the mandibular incisive neurovascular bundle [32]. von Arx T et al [6] reported lower lip hypaesthesia and altered pulp sensitivity of anterior mandibular teeth after removal of bone grafts from mandibular anterior region. Sbordone et al [33] assessed neurosensory disturbances and tooth-pulp sensitivity loss following mandibular para symphyseal bone harvesting, leaving 5 mm of space between the foramina, dental root apices and basal bone when creating osteotomy lines. The study showed that 39% of teeth lost pulp sensitivity when the osteotomy line was within 5 mm of the root apices. Also, 33% of teeth lost vitality even when the osteotomy was >5 mm from the teeth apices, lending to the conclusion that loss of pulpal sensitivity may not be correlated to the distance between the root apex and harvested bone. This may be attributed to the anatomical course of the MIC in the buccal-lingual direction and distance of MIC from buccal and lingual cortical plate.

It can be concluded thatthis original research article can serve as apotential reference for localization of MIC and its associated vital anatomic structures before and during dentoalveolar surgical procedures in mandibular anterior region in patients with particular age groups.The interforaminal area should not be considered truly a safer zone for any kind of surgical procedures and endodontic considerations in the form of pulp sensitivity and vitality changes should be given equal importance. The inter foraminal region should be evaluated thoroughly in 3-dimensional images begore planning any surgical intervention in this region.

Limitations:

Ours is a retrospective study in which we could not assess chewing pattern, parafunctional habits and bone density of the patients. Further longitudinal studies can be planned with considerations of possible related factors.

Declaration of competing interest:

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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