OPEN ACCESS
Saudi Journal of Oral and Dental Research
Abbreviated Key Title: Saudi J Oral Dent Res
ISSN 2518-1300 (Print) | ISSN 2518-1297 (Online)
Scholars Middle East Publishers, Dubai, United Arab Emirates
Journal homepage: https://saudijournals.com

Original Research Article | **Oral Maxillofacial Surgery**

The Prevalence of Mandibular Incisive Canal among a Sample of Yemeni Adults Obtained from Cone-beam Computed Tomography

Akram Nasher[1*], Ali Juain[2], Sam Da'er[3], Abdulla Farhan[4], Naif Alareqi[5]

[1]Assistant Professor of Oral Maxillofacial Surgery, Faculty of Dentistry, Sana'a University, Sana'a, Yemen
[2]Master Degree in Oral Maxillofacial Surgery, Faculty of Dentistry, Sana'a University, Sana'a, Yemen
[3]Assistant Professor of Oral Maxillofacial Surgery, Faculty of Dentistry, Sana'a University, Sana'a, Yemen
[4]Assistant Professor of Oral Maxillofacial Surgery, Faculty of Dentistry, Sana'a University, Sana'a, Yemen
[5]Bachelor Degree, Faculty of Dentistry, Sana'a University, Sana'a, Yemen

DOI: 10.36348/sjodr.2023.v08i01.009 | **Received:** 18.12.2022 | **Accepted:** 25.01.2023 | **Published:** 31.01.2023

***Corresponding author:** Akram Nasher
Assistant Professor of Oral Maxillofacial Surgery, Faculty of Dentistry, Sana'a University, Sana'a, Yemen

Abstract

Aim of this study*:** It was to determine the prevalence of Mandibular Incisive Canal (MIC) among a sample of Yemeni adults obtained from Cone-beam Computed Tomography (CBCT). ***Materials and Methods: This is a retrospective descriptive cross-sectional study which is conducted in Yemen to evaluate CBCT images of 180 subjects, 360 sides were evaluated respectively. The samples were 74 males (41.1%) and 106 females (58.9%). ***Result*:** Of the 180 subjects and 360 sides, 167 right (92.8%) and 171 left (95%) Sides were found to have MIC. Among these subjects, 166 (96.5%) had MIC bilaterally and 6 (3.5%) were unilaterally. According to gender, females were (98.1%) and males (91.9%), while among age groups ≤ 40 years (94.3%) and > 40 years (97.3%) were found to have MIC. The mean height of MIC was 1.77 ±.45mm and the mean width was 1.66 ±.44 mm. The mean length of MIC was 12.74 ±4.4 mm. The mean distance from MIC to the alveolar process was 16.77 ±4.06 mm and to the inferior border of the mandible was 8.61 ±1.9 mm. The mean distance from MIC to the labial bony surface was 3.12 ±1.09 mm and to the lingual bony surface was 4.35 ±1.5 mm. All the mean values of the linear measurements were slightly higher in males than that of females. There were statistically significant differences in D3, D5 & D6 between genders and in D3, D4 & D5 between ages ($P < 0.05$). But there was no statistically difference between sides. ***Conclusion*:** The MIC is present with a significant percentage of 95.6 % of Yemeni adults, which emphasizes the need to raise the awareness of MIC position and configuration among general practitioners and maxillofacial surgeons.

Keywords: Mandibular Incisive Canal (MIC), Cone-beam Computed Tomography, alveolar process, labial bony surface.

INTRODUCTION

The mandibular incisive canal is a bony canal within the anterior mandible that runs bilaterally from the mental foramina usually to the region of the ipsilateral lateral incisor teeth. After branching into the mental nerve that exits the foramen of the same name, the inferior alveolar nerve continues anteriorly within the mandibular incisive canal as the incisive nerve, providing innervation to the mandibular first premolar, canine, lateral and central incisors [1] Figure 1 & Figure 2.

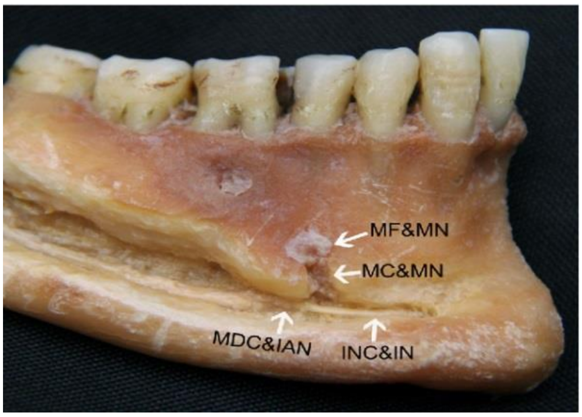

Figure 1: MIC pointed by red arrow

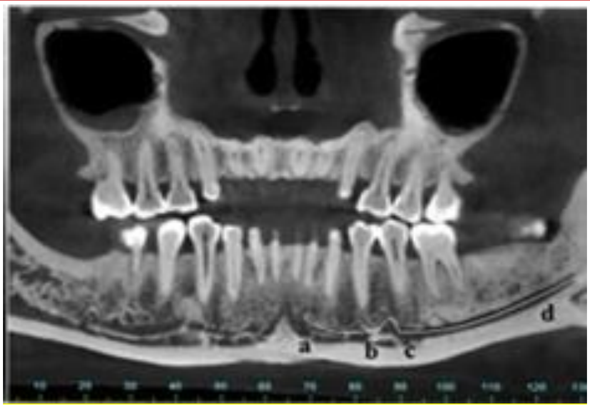

Figure 2: Panoramic view demonstrates MIC

The neurovascular bundles may run through intertrabecular spaces of chin cancellous bone in some cases [2]. Furthermore, there is no distinct incisive canal (MIC) in many cases; because the nerve is organized in a network or plexus, and therefore is not detectable on radiographs [3].

Recently, increases in life expectancy worldwide have led to an increased demand for oral rehabilitation by surgical procedures, such as implant placement and bone grafts. Although dental implant placement in the mandibular interforaminal region is regarded as a relatively safe procedure, patients may experience sensory disturbances after surgical procedures in anterior segment [4].

Mandibular incisive nerve invasion and neuropathic pain may occur after the placement of an implant in the interforaminal region due to the perforation of incisive canal and nerve [5, 6]. In addition, traditional approaches have some drawbacks in accurately defining the MIC location and size. The bucco-lingual dimension, for example, can't be identified in panoramic radiographs. Also, the unsteady magnification of panoramic radiography renders this approach ineffective for vertical distance assessment [7].

Currently, the most successful and precise technology available for quantitatively assessing the location and size of the MIC is high resolution CBCT. It is an excellent imaging system for oral and maxillofacial application, providing a uniform magnification, three dimensional reconstructions using software, and the high geometric accuracy, as well as low radiation doses with relatively low cost. For the study of teeth, spongy bone, and lamina dura, the accuracy of CBCT has been judged to be equivalent to multi-slice computed tomography [8, 9].

Furthermore, because no pervious study up to the researcher's knowledge has been conducted to study the prevalence of the MIC among the Yemeni population in (Sana'a, Ebb and Taiz) cities. The findings of this study can be used as a key guideline for surgeons and dentists involved in conducting surgical procedures in the anterior mandibular region. Raising the perception of mandibular incisive canals (MIC's) presence, and the anatomical configuration of the region may play an essential role during the treatment plan, in terms of preventing complications during and after surgical procedures, leading to better and more fulfilling outcomes.

MATERIALS AND METHODS

Retrospective descriptive cross-sectional study survey was conducted to determine the prevalence of the mandibular incisive canal (MIC) among a sample of Yemeni adults obtained from CBCT images. This study was conducted in the centers of CBCT images (AL-Waleed, AL Mamoon and Sheba (Sana'a city), 3D X-Ray (Ebb city), Taiz Digital X-Ray (Taiz city) in Yemen. The exposure settings are: field of view, 8 cm_12 cm; tube voltage, 90 kVp; tube current, 4.0 mA; scan time, 24 seconds; and isotropic voxel size,0.30mm. The target population were all cases that have CBCT images to the area of mandibular incisive canal that present in the records of three cities (Sana'a, Ebb and Taiz) x-ray centers in Yemen which meet the inclusion criteria, from the period of Jun 2017 to Jun 2019. Sample size is (180) Cone-beam Computed Tomography images calculated by formula of cross-sectional survey sample size.

Inclusion Criteria

- CBCT images of Yemeni adults that show the incisive canal area (the area of interest).
- The period of Jun 2017 to Jun 2019.
- Age group 16–80 years.

Exclusion Criteria

- Pathological findings in the MIC area.
- Image artefacts or blurring affecting the image quality**.**
- Subjects below 16 y and above 80 y.
- CBCT of non- Yemeni adults.
- Previous surgery in the same area**.**

CBCT Imaging

In this study, all images were taken by a CBCT system unit (Pax-Flex3DP2, Vatech, Korea) .The 180 CBCT images were taken by the CBCT unit (Vatech, Korea),which was the same in all centers with the following exposure setting: field of view, 5*5 ,5*8, 8.5*8.5, 8.5*12 and 9*12 cm; tube voltage , 90 kVp; tube current, 4.0 mA; scan time , 24 seconds ; and isotropic voxel size, 0.160-0.200 mm for full mouth scan and 0.060-0.020 mm for others. The detector unit complete 2000 rotation around the patient's head in 14 seconds. The software utilized was Ez3D plus which capable of reconstructing the primary data and multi-planar reformation of the original images. Moreover, the images were analyzed and the measurements were done using the tools given in the software (Ez3D plus with Ez3D-I software). A single operator worked with all the files from a personal laptop (Hp – Core (TM) i7-4710MQ CPU @ 2.50GHz with a Ram of 800 GB with OEM-8992662-00400-00426 (Figure 3).

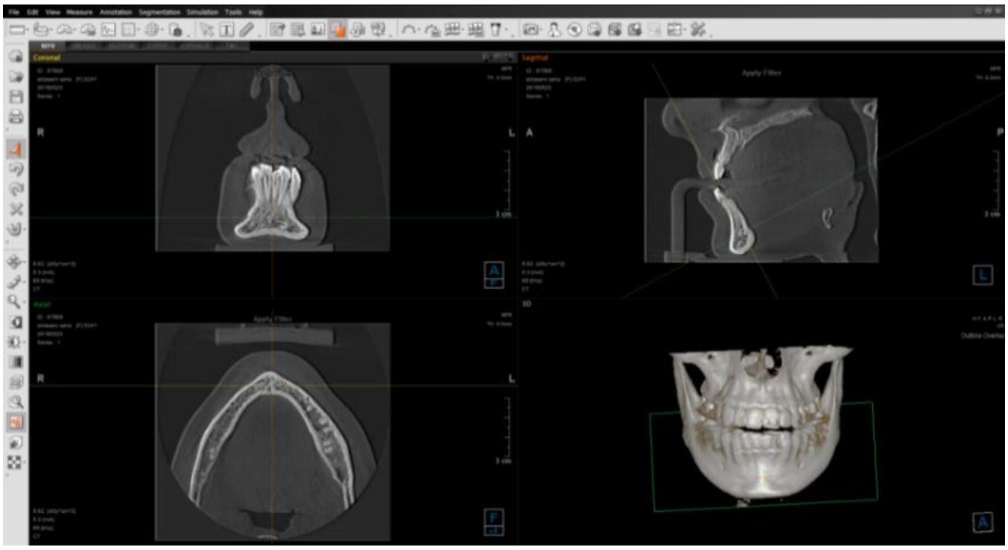

Figure 3: A view from the Ez3D Plus Software

Image Analysis

The CBCT images were evaluated for the presence of the MIC. The existence of the MIC was seen by the identification of a radiolucent image within the trabecular bone bounded by radiopaque cortical plates, clearing the canal limits, and extending to the anterior area [10] (Figure 4). The MIC was identified separately on both sides by panoramic reconstructing images of the CBCT. After that, it was drawn by a red color-circle marker via the software to identify its whole path by using 0.5 mm slice thickness (Figure 5).

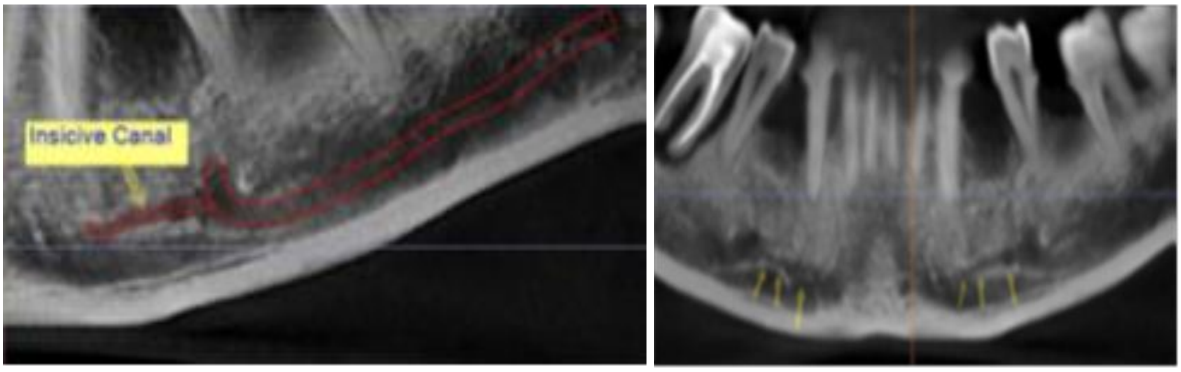

Figure 4: Demonstration of the Identified MIC

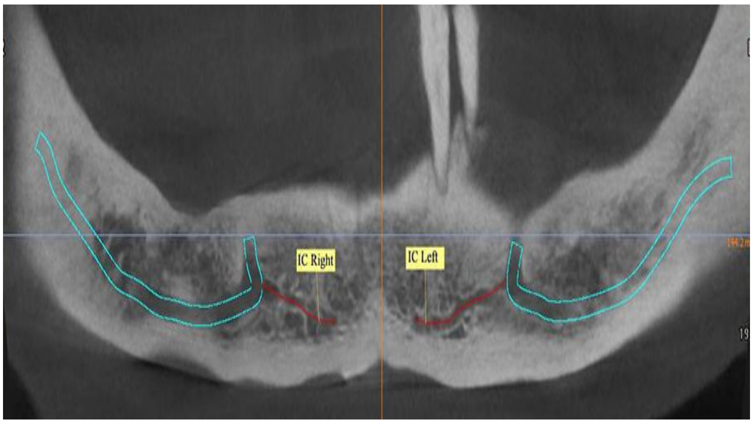

Figure 5: Demonstration of the Identified MIC

The images of each case were managed and analyzed through the following steps:

First: The axial sections were generated in a way to exhibit the right and left MF together at the same time and in the same level (Figure 6). Second: The panoramic curve was drawn from the right MF to the left MF on the axial section to obtain the panoramic view (Figure 7). Third: Multiple serial cross-sections from the 3D view were obtained (Figure 8). Then on the reconstructed panoramic view CBCT images, the software ruler was enhanced to measure the distance (in millimeters) of linear measurements (dependent variables, D1, D2, D3, D4, D5, D6, D7).

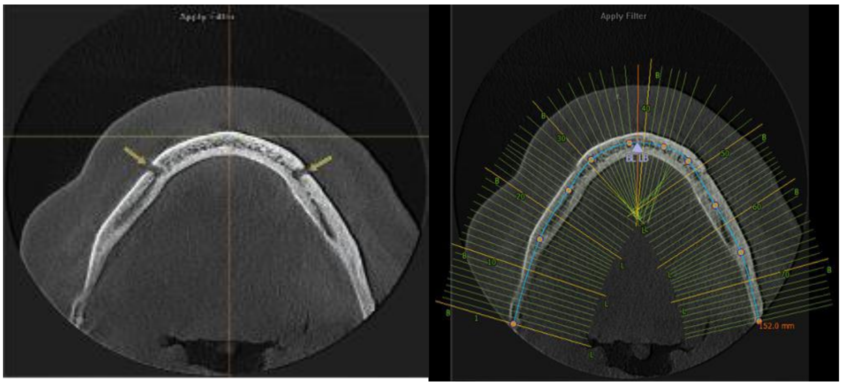

Figure 6: Right and Left MF at the Same Level

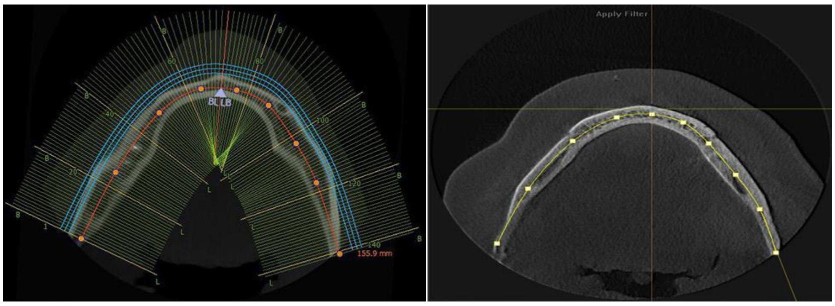

Figure 7: Panoramic Curve on the Axial Section

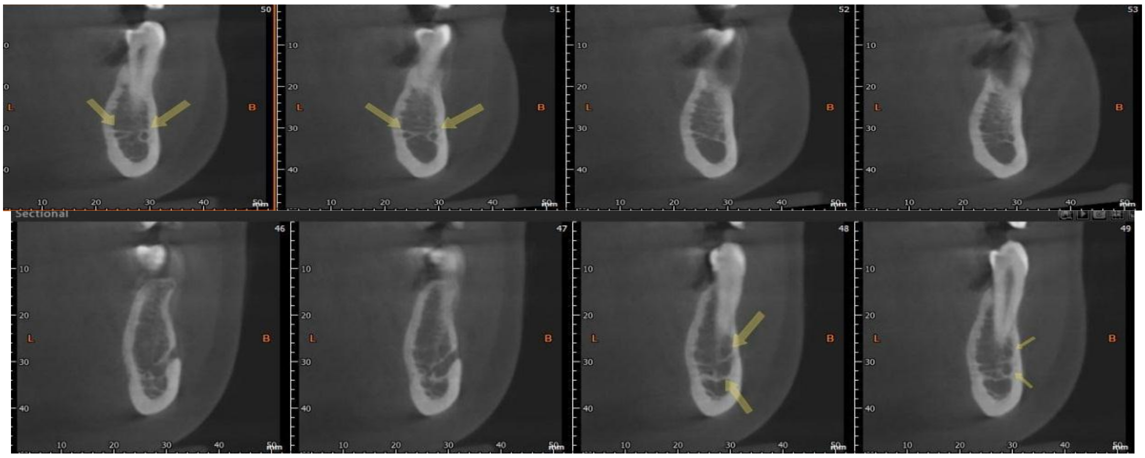

Figure 8: Sagittal Cross-Sections Obtained from the 3D View

Linear Measurements of MIC

Average height of the Mandibular incisive canal (D1), Average width of the Mandibular Incisive Canal (D2), Average length of the Mandibular Incisive Canal (D3), Average vertical distance from the superior aspect of MIC to the alveolar process (D4), Average vertical distance from the inferior aspect MIC to the inf. Border of the mandible (D5), Average horizontal distance from anterior aspect of MIC to the labial bony plate (D6) and Average horizontal distance from posterior aspect of MIC to the lingual bony plate (D7) As demonstrated in (Figure 9).

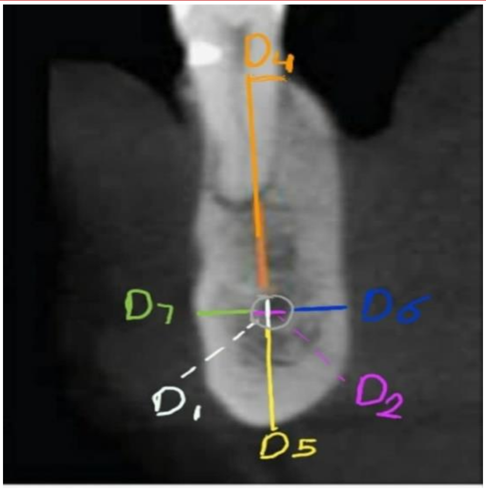

Figure 9: Linear measurements of MIC (D1, D2, D4, D5, D6&D7)

Statistical Method

All statistical analysis was performed using the statistical Package for Social Science (SPSS) version 24. Odd Ratio (OR) was used to investigate the association between MIC with sides, genders as well as ages. The confidence interval (CI) (95% confidence level was used) and the Chi-square test were used to investigate the significant differences in the prevalence rate of MIC between sides, genders and ages, the result considered significant when the P-value is less than 0.05. The Welch's t-test was used to compare the significant differences between the mean values of MIC's linear measurements according to sides, genders and ages.

RESULTS

CBCT images of 180 subjects (360 sides), were evaluated retrospectively for this study. 74 (41.1%) of the subjects were males and 106 (58.9%) were females and 105 (58.3 %) of subjects were ≤ 40 years and 75(41.7 %) were > 40 years. Of 180 subjects and 360 sides, 172 (95.6%) subjects and 338 (93.9%) sides were found to have MIC and 8 (4.4%) subjects and 22(6.1%) sides were not found to have the canal. Among these subjects, 166 (96.5%) were found to have MIC bilaterally and 6 (3.5%) were unilateral, this shows a clear statistically significant difference p< 0.05, in which 5(83.3%) were found on the right and 1 (16.7%) were on the left (Table 1). There was no statistically significant difference between the right and left sides of the subjects in the prevalence of MIC 167 (92.8%) and 171 (95%), respectively). (P-value=0.379) (Table 2). The prevalence of MIC in females (98.1%) was slightly higher than that of males (91.9%), which shows the statistically significant difference between the male and female subjects (P-value= 0.046) (Table 3). The prevalence of MIC in age group ≤ 40 years (94.3%) was slightly less than the age group > 40 years (97.3%). But there was no statistically significant difference between the two groups in the prevalence of MIC (P-value=0.343) (Table 4). The mean vertical height of the MIC (D1) was 1.77 ± 0.45 mm with a range from 0.40 to 3.10 mm, the mean width of the MIC (D2) was 1.66 ± 0.44 mm with a range from 0.70 to 3.30 mm and the mean length of the MIC (D3) was 12.74 ± 4.40 mm with a range from 3.60 to 27.10 mm (Table 5).

Table 1: Prevalence of MIC 0f Total Sample

	Subjects (n=180)	Sides (n=360)
Present	172 (95.6%)	338 (93.9%)
Absence	8(4.4%)	22 (6.1%)
	Subjects (n=172)	Sides (n=338)
Bilaterally	166 (96.5%)	332 (98.2%)
Unilaterally	6 (3.5 %)	6 (1.8%)
On Right (n=5)	5(83.3%)	5(83.3%)
On Left (n=1)	1 (16.7%)	1 (16.7%)

Table 2: The Prevalence of MIC according to the Side and the Association of MIC Prevalence with the Side

Side (n=360)	Presence (%)	OR	CI 95%	P-value*
Right (n=180)	167(92.8)	0.98	0.93-1.03	0.379
Left (n=180)	171(95.0)	1.44	0.63-3.29	0.379

*Chi-square

The mean vertical distance from MIC to the alveolar process (D4) was 16.77± 4.06 mm with a range from 2.30 to 26.60 mm and the mean vertical distance from the MIC to the inf. border of the mandible (D5) was 8.61 ± 1.94 mm with a range from 4.00 to 13.80 mm (Table 5).

Table 3: The Prevalence of MIC according to Gender and the Association of MIC Prevalence with the Gender

Gender (n=180)	Presence (%)	OR	CI 95%	P-value*
Male	68 (91.9)	0.23	0.05 -1.12	0.046*
Female	104 (98.1)	1.07	0.99 -1.15	0.046*

*Chi-square * P-value< 0.05

The mean horizontal distance from the MIC to the labial bony plate (D6) was 3.12 ± 1.09 mm with a range from 0.70 to 7.30 mm and the mean horizontal distance from the MIC to the bony lingual plate (D7) was 4.35 ± 1.51 mm with a range from 0.90 to 10.60 mm (Table 5). There was no statistically significant difference between the right and left sides in the mean of linear measurements of MIC (D1, D2, D4, D5, D6&D7).

Table 4: The Prevalence of MIC according to Age

Age (n=180)	Presence (%)	OR	CI 95%	P-Value*
≤ 40 years	**100 (94.3)**	**0.97**	**0.91 –1.03**	**0.343**
> 40 years	**72 (97.3)**	**2.09**	**0.44 10.09**	**0.343**

*Chi-square

Table 5: Linear Measurements of the Total Sample

Linear Measurements	N	Mean	SD	Min.	Max.
D1	**338**	**1.77**	**.454**	**.40**	**3.10**
D2	**338**	**1.66**	**.441**	**.70**	**3.30**
D3	**338**	**12.74**	**4.402**	**3.60**	**27.10**
D4	**338**	**16.77**	**4.063**	**2.30**	**26.60**
D5	**338**	**8.61**	**1.945**	**4.00**	**13.80**
D6	**338**	**3.12**	**1.091**	**.70**	**7.30**
D7	**338**	**4.35**	**1.519**	**.90**	**10.60**

DISCUSSION

The mandibular canal divides in the region of the first lower premolar's root into two branches: mental canal and incisive canal [11, 12]. The mandibular incisive canal often begins mesially to the projection of the mental foramen and goes forward parallel to the roots of the anterior teeth [13].

The MIC which has anatomical variations, does not end at the same point [14]. Therefore, in the current study, the criteria for the measurements were based on the measurements of the canal at its middle point, whereas the criteria in previous studies were based on the evaluation of the incisive canal in different parts separately Gomes, L. T., *et al.*, [15] measurements of the canal at its origin Kajan, Z. D. and A. Salari,. [16] or at predetermined distances of 6, 9, 12 and 15 mm mesially to the mental foramen Makris, N *et al.*, [9].

In the present study, the prevalence of MIC was 95.6 % similar to the result in the studies conducted by Mraiwa, N., *et al.*, [17], Yovchev, D., *et al.*, [13], and Panjnoush, M., [18] equal to 97.5%. But slightly less than [19] 100%, Kong, N., *et al.*, and Fuentes, R. N., *et al.*, [20, 21] 98.19% and more than Orhan, K., *et al.*, [22] 91%, Sakhdari, S., L [23] 87.5% and Ghoncheh, Z., [24] 90%.

This study showed that MIC is present in 166 subjects (96.5%) bilaterally, and unilaterally in 6 (3.5%). There was a statistically significant difference. Likewise, other studies which reported the MIC prevalence to be higher bilaterally, as [18] which investigated 200 CBCT 400 sides and reported the canal bilaterally in 94% and unilaterally in 3.5.

With regard to side predilection, the present study reported the prevalence of MIC on the right side as (92.8%) which was almost similar to that on the left side (95.0%). There was no statistically significant difference between the right side and left side in the prevalence of MIC (P-value=0.379). These findings were similar to the majority of previous studies which have found that no statistically significant difference between the right side and left side in the prevalence of MIC [24-26]. With regard to gender predilection, the present study reported the prevalence of MIC in females as (98.1%) which was slightly higher than that of males (91.9%) indicating that there is a statistically significant difference between the males and females in the prevalence of MIC (P-value=0.046). These findings were close to the study of Gomes, L.T., *et al.*, [15] who found the MIC prevalence was more in females (80%) than males (76%). However, Fuentes, R. N., *et al*., [21] found that the prevalence of MIC is more in males (57%) than females (49.9%), Kajan, Z. D. and A. Salari, [16] reported higher prevalence in males (97.6%) than females (93%), as well as Cho, B.-H. and Y.-H. Jung, [26] showed higher prevalence in males 85%, while in females 82.4%.

According to age, the prevalence of MIC in age group > 40 years (97.3%) was slightly higher than that in age group ≤ 40 years (94.3%). But there was no statistically significant difference between the two groups in the prevalence of MIC (P-value=0.343), as similar to most previous studies [16, 26, 27] Consequently, the current study showed a larger mean height and width of MIC 1.77mm, 1.66mm respectively than those reported by Pires, C.A., *et al*., [14] 0.40 mm and by Kong, N., *et al*., [20] 0.89 mm. And similar to Xu, Y., *et al*., [11] 1.76mm, Gomes, L.T., *et al*., [15] 1.4mm. Also, it is less than those of Ramesh, A., *et al*., [28] 2.5mm Gilis, S., *et al*., [29] 2.3mm. Differences in the study design, technical reasons (voxel size, differences between CBCT), and individual peculiarities could be responsible for the difference. [13]. The study found that the mean length of MIC (D3) in all cases was 12.74 mm; ranging from (3.60 to 27.10) mm, which is relatively close to that of Orhan, K., *et al*., [22] 12.4 mm, Lim, J.T.S., *et al*., [30] 11.31 mm.

The mean average / SD of the vertical distance from the superior aspect of MIC to the alveolar process (D4) was (16.77 / 4.063) mm, more than that of the vertical distance from the inferior aspect of MIC to the inferior border of the mandible (D5) (8.61 / 1.945) mm. This indicates that the course of the MIC was directed inferiorly. This finding coincides with that of [17], *but* does not coincide with those of Pires, C. A., *et al*., [14] and Pereira-Maciel, P. C., [19] who showed the superior location of MIC. The mean / SD of D4, according to side; right and left, (16.77 / 3.999) mm and (16.77 / 4.137) mm. There was no significant difference on both sides (p =.995).

The reason of dimensional variations is due to the metabolic changes Kajan, Z.D. and A. Salari, [16] in the area of alveolar bone and the state of dentation. The vertical bone resorption often occurs in edentulous patients; so, the distance from the MIC to the alveolar crest maybe greatly reduced Kong, N *et al*., [20].

Moreover, the mean average SD of the horizontal distance from the MIC to the labial bony surface of the mandible (D6) (3.12 / 1.091) mm, was less than that of the horizontal distance from the MIC to the lingual bony surface of the mandible (D7) (4.35 / 1.519) mm. This indicates that the course of the MIC was directed slightly buccally Kong, N *et al*., [20]. This finding agrees with those of [24, 14, 16, 28, 20] who showed the buccal location of MIC. Oppositely, Rosa, M. B *et al*., [25] reported 71.06% of cases had a lingual path of the MIC.

Identification of the location of the MIC is as essential as that of the IAN canal in the mandible, as it might lead to injury of the nerve and result in postoperative myalgia and other nerve related problems Hirsch, J.-M. and Wismeijer, D. V., *et al*., [31, 32]. Therefore, the MIC surrounding bone measurements were analyzed in this study.

CONCLUSION

The clinical significance of this study can be realized through mapping of the incisive canal and its proximity relative to anatomic structures during pre-surgical treatment planning. Collectively, the data from this study indicates surgical anatomic relationships should be considered in pre-surgical planning using CBCT to prevent neurosensory disturbances and other possible complications. The MIC is present with a significant percentage of 95.6% of Yemeni adults, which emphasizes the need to raise the awareness of MIC position and configuration among general practitioners and maxillofacial surgeons.

REFERENCES

1. Greenstein, G., Cavallaro, J., & Tarnow, D. (2008). Practical application of anatomy for the dental implant surgeon. *Journal of periodontology*, *79*(10), 1833-1846.
2. Greenstein, G., & Tarnow, D. (2006). The mental foramen and nerve: clinical and anatomical factors related to dental implant placement: a literature review. *Journal of periodontology*, *77*(12), 1933-1943.
3. Shaban, B., Khajavi, A., Khaki, N., Mohiti, Y., Mehri, T., & Kermani, H. (2017). Assessment of the anterior loop of the inferior alveolar nerve via cone-beam computed tomography. *Journal of the Korean Association of Oral and Maxillofacial Surgeons*, *43*(6), 395-400.
4. Liang, X., Lambrichts, I., Corpas, L., Politis, C., Vrielinck, L., Ma, G. W., & Jacobs, R. (2008). Neurovascular disturbance associated with implant placement in the anterior mandible and its surgical implications: literature review including report of a case. *Chinese Journal of Dental Research*, *11*(1), 56.
5. Kütük, N., Demirbas, A. E., Gönen, Z. B., Topan, C., Kiliç, E., Etöz, O. A., & Alkan, A. (2013). Anterior mandibular zone safe for implants. *Journal of Craniofacial Surgery*, *24*(4), e405-e408.
6. Bobat, M. A. Y. (2015). Clinical Significance of the Anterior Loop of the Mental Nerve: Anatomical Dissection of a Cadaver Population at the University of the Witwatersrand.
7. Scarfe, W. C., Farman, A. G., & Sukovic, P. (2006). Clinical applications of cone-beam computed

tomography in dental practice. *Journal-Canadian Dental Association*, *72*(1), 75.

8. 8. Carrafiello, G., et al., *Comparative study of jaws with multislice computed tomography and cone-beam computed tomography.* La radiologia medica, 2010. **115**(4): p. 600-611.
9. 9. Makris, N., et al., *Evaluation of the visibility and the course of the mandibular incisive canal and the lingual foramen using cone beam computed tomography.* Clinical oral implants research, 2010. **21**(7): p. 766-771.
10. Raitz, R., Shimura, E., Chilvarquer, I., & Fenyo-Pereira, M. (2014). Assessment of the mandibular incisive canal by panoramic radiograph and cone-beam computed tomography. *International journal of dentistry*, *2014*.
11. Xu, Y., Suo, N., Tian, X., Li, F., Zhong, G., Liu, X., ... & Tian, H. (2015). Anatomic study on mental canal and incisive nerve canal in interforaminal region in Chinese population. *Surgical and Radiologic Anatomy*, *37*, 585-589.
12. Juodzbalys, G., Wang, H. L., & Sabalys, G. (2010). Anatomy of mandibular vital structures. Part II: mandibular incisive canal, mental foramen and associated neurovascular bundles in relation with dental implantology. *Journal of oral & maxillofacial research*, *1*(1).
13. Yovchev, D., Deliverska, E., Indjova, J., & Zhelyazkova, M. (2013). Mandibular incisive canal: a cone beam computed tomography study. *Biotechnology & Biotechnological Equipment*, *27*(3), 3848-3851.
14. Pires, C. A., Bissada, N. F., Becker, J. J., Kanawati, A., & Landers, M. A. (2012). Mandibular incisive canal: cone beam computed tomography. *Clinical implant dentistry and related research*, *14*(1), 67-73.
15. Gomes, L. T., de Almeida Barros Mourão, C. F., Braga, C. L., de Almeida, L. F. D., de Mello-Machado, R. C., & Calasans-Maia, M. D. (2018). Anatomic evaluation of the incisive canal with cone beam computed tomography and its relevance to surgical procedures in the mental region: a retrospective study in a Brazilian population. *Oral and Maxillofacial Surgery*, *22*, 379-384.
16. Kajan, Z. D., & Salari, A. (2012). Presence and course of the mandibular incisive canal and presence of the anterior loop in cone beam computed tomography images of an Iranian population. *Oral Radiology*, *28*, 55-61.
17. Mraiwa, N., Jacobs, R., Moerman, P., Lambrichts, I., van Steenberghe, D., & Quirynen, M. (2003). Presence and course of the incisive canal in the human mandibular interforaminal region: two-dimensional imaging versus anatomical observations. *Surgical and radiologic anatomy*, *25*, 416-423.
18. Panjnoush, M., Rabiee, Z. S., & Kheirandish, Y. (2016). Assessment of location and anatomical characteristics of mental foramen, anterior loop and mandibular incisive canal using cone beam computed tomography. *Journal of Dentistry (Tehran, Iran)*, *13*(2), 126.
19. Pereira-Maciel, P., Tavares-de-Sousa, E., & Oliveira-Sales, M. A. (2015). The mandibular incisive canal and its anatomical relationships: A cone beam computed tomography study. *Medicina oral, patologia oral y cirugia bucal*, *20*(6), e723.
20. Kong, N., Hui, M., Miao, F., Yuan, H., Du, Y., & Chen, N. (2016). Mandibular incisive canal in Han Chinese using cone beam computed tomography. *International Journal of Oral and Maxillofacial Surgery*, *45*(9), 1142-1146.
21. Fuentes, R., Arias, A., Bucchi, C., Saravia, D., & Dias, F. (2017). Prevalence and morphometric characteristics of the mandibular incisive canal through panoramic radiographs in a Chilean population. *International Journal of Morphology*, *35*(3), 931-937.
22. Orhan, K., Icen, M., Aksoy, S., Ozan, O., & Berberoglu, A. (2014). Cone-beam CT evaluation of morphology, location, and course of mandibular incisive canal: considerations for implant treatment. *Oral Radiology*, *30*, 64-75.
23. Sakhdari, S. H., Hafezi, L., & Esmaili, M. O. N. A. (2016). Prevalence of the Inferior Alveolar Nerve's Anterior Loop and Mandibular Incisive Canal by Use of Cone Beam Computed Tomography (CBCT) in an Iranian Population. *Journal of Research in Dental and Maxillofacial Sciences*, *1*(3), 14-21.
24. Ghoncheh, Z., Zadeh, B. M., & Shaeri, S. (2019). Prevalence and position of mandibular incisive canal, anterior loop of the mandibular canal and lingual foramen using cone beam computed tomography. *Journal of Craniomaxillofacial Research*, 143-150.
25. Rosa, M. B., Sotto-Maior, B. S., Machado Vde, C., & Francischone, C. E. (2013). Retrospective study of the anterior loop of the inferior alveolar nerve and the incisive canal using cone beam computed tomography. *Int J Oral Maxillofac Implants*, *28*(2), 388-392.
26. Cho, B. H., & Jung, Y. H. (2015). Assessment of mandibular incisive canal using cone-beam computed tomography in Korean population. *The Journal of the Korean dental association*, *53*(12), 967-974.
27. Ferreira-Barbosa, D. A., Kurita, L. M., Pimenta, A., Cordeiro Teixeira, R., Silva, P. G. D. B., Rodrigues-Ribeiro, T., ... & Costa, F. W. G. (2020). Mandibular incisive canal-related prevalence, morphometric parameters, and implant placement implications: a multicenter study of 847 CBCT scans. *Medicina Oral, Patolog a Oral y Cirug a Bucal*, 25(3), p. e337.
28. Ramesh, A. S., Rijesh, K., Sharma, A., Prakash, R., & Kumar, A. (2015). The prevalence of mandibular incisive nerve canal and to evaluate its average location and dimension in Indian

population. *Journal of Pharmacy & Bioallied Sciences*, *7*(Suppl 2), S594.

29. Gilis, S., Dhaene, B., Dequanter, D., & Loeb, I. (2019). Mandibular incisive canal and lingual foramina characterization by cone-beam computed tomography. *Morphologie*, *103*(341), 48-53.
30. Lim, J. T. S., Kang, W. J., Ajit Bapat, R., Kanneppady, S. K., & Pandurangappa, R. (2019). Evaluation of mandibular incisive canal using cone beam computed tomography in Malaysians. *Journal of maxillofacial and oral surgery*, *18*, 596-603.
31. Hirsch, J. M., & Brånemark, P. I. (1995). Fixture stability and nerve function after transposition and lateralization of the inferior alveolar nerve and fixture installation. *British Journal of Oral and Maxillofacial Surgery*, *33*(5), 276-281.
32. Wismeijer, D. V., Van Waas, M. A. J., Vermeeren, J. I. J. F., & Kalk, W. (1997). Patients' perception of sensory disturbances of the mental nerve before and after implant surgery: a prospective study of 110 patients. *British Journal of Oral and Maxillofacial Surgery*, *35*(4), 254-259.