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Investigating the Mandibular Incisive Canal and Its Relationship with Adjacent Landmarks in CBCT in Zahedan City

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Abstract

Objectives: Due to the importance of identifying the location of the incisive canal before intraosseous dental implants and symphysis bone removal surgery, and in order to prevent complications and disorders after surgery in this area, appropriate imaging methods should be used. Therefore, this study was performed to investigate the incisive mandibular canal and its relationship with adjacent landmarks in CBCT.

Materials and Methods: This retrospective study includes 125 radiographic images from a private clinic archive. The sampling method was easy and accessible to collect information from radiographic images and demographic information forms, and SPSS19 software was used for data analysis.

Results: The results of the present study showed that the mean age of participants in the study was 40.40 ±11.6. The ability of CBCT to detect mandibular incisive canal in female patients was 62 out of 69 (89%), and in male patients it was 51 out of 56 (91%). There was a significant difference between the right and left mandibular incisive canals in men and women. In men and women, there was a significant difference in the distance between the incisive mandibular canal and the root canal of the right and left canines by CBCT. There was also a significant difference between the mandibular incisive canal to the right and left lower cortex by CBCT in men and women. There was also a significant difference between the distance of the mandibular incisive canal to the right and left buccal plate by CBCT in men and women. The distance between the mandibular incisive canal and the right lingual plate measured by CBCT did not differ significantly between men and women.

Conclusion: CBCT imaging quality, accuracy, and resolution have very high efficiency in detecting and determining the position of the mandibular incisive canal.

Keywords: tomography, cone beam, mandible.

Introduction

The mandibular canal is one of the normal anatomical structures of the mandible associated with implant treatment, which extends diagonally down and anteriorly from the mandibular hole in the ramus and then proceeds horizontally in the mandibular trunk (1). Mainly between the roots of the first and second premolars or below the lower second premolars, this canal is divided into two parts, the chin and the incisor. The chin branch, with a rotation upward and distal called the anterior ring, exits the chin hole at the buccal level of the mandible, and the incisor branch extends from inside the incisor canal below the root of the lower incisors to the site of the lingual hole (2, 3).

The lower alveolar canal and chin hole are important anatomical structures that should be given special attention in the placement of implants and other mandibular surgeries (4). Although many histological and radiographic studies emphasize the importance of vital structures in the posterior part of the mandible, only a few studies have suggested the existence of important anatomical structures in the anterior mandible, such as the incisive canal and the lingual foramen. However, in these studies, the potential problems and risks that may occur during surgery in the presence of these buildings have not been emphasized (5, 6). Most books and sources on human anatomy do not provide an accurate description of the location and nature of these buildings.

Before performing any surgery, it is very important to pay attention to the anatomical structures of the operation area and determine their exact position (7). By providing appropriate radiography of the patient and determining the location of these structures, the occurrence of adverse complications during and after surgery is significantly reduced (8). Radiographic diagnosis of a disease requires accurate knowledge of radiographic signs and natural structures. This diagnosis cannot be made without considering the variety and variation of natural anatomical structures. T

The incisive branch of the mandibular canal is the anterior extension of the inferior alveolar canal from the side of the chin hole, which includes the neural vascular bundles in the anterior part of the mandible and is clinically important (9). The incisive channel in CBCT images is seen as a radiolucency with a rim opac (10).

The neurovascular nature of the incisive canal seems insignificant, perhaps because the numerous anastomoses in the area are thought to cover any canal damage and do not pose a serious clinical problem. However, a closer look at the articles reveals that these vital structures should also be considered because of the potential for hemorrhage and neurological lesions such as traumatic neuroma (11). Various studies have been performed on the mandibular incisive canal and its relationship to adjacent landmarks in the CBCT.

In 2020, Ramaswamy et al. evaluated the mandibular incisive canal (MIC) and its relationship with adjacent landmarks using CBCT in 50 patients aged 20 to 70 years, and found a significant association between the mandibular incisive canal with the canine root tip, cortex end, and the buccal cortex plate. Also, the diameter of the incisive canal is larger in men compared to women, and it is larger on the left compared to the right (12). Malusare et al. in 2019 in a retrospective study determining the dimensions of the mandibular incisive canal with landmarks adjacent to the CBCT in the Indian population showed that the canal length is 13.4 mm on the right and 12.4 mm on the left (13). For comparison, Uchida et al. (2009) measured the anterior loop length (ALL) of the mandibular canal and the mandibular incisive canal diameter (ICD) at their origin in a dry skull using CBCT. According to the results, the average difference between anatomical and CBCT measurements is 6.6 mm or less for both ICD and ALL (14).

Due to the importance of identifying the location of the incisor canal before placement of intraosseous implants and symphysis bone removal surgery, and in order to prevent complications and disorders after surgery in this area, appropriate imaging methods should be used. Due to the high measurement accuracy and high quality of CBCT images as well as the low received radiation dose, the aim of this study was to investigate the location of the mandibular incisive canal and its relationship with adjacent landmarks using CBCT.

Materials & Methods

The present study was a descriptive-analytical and retrospective study. The study sample was selected from radiographic images available in the archives of the Zahedan Dental Clinic. The method of sample selection was simple random selection from patients' files, so that file numbers were selected using a table of random numbers. Inclusion criteria included prescribing CBCT radiographs, images with correct imaging technique, and age over fifteen years. Exclusion criteria included the presence of pathological lesions and fractures in the study area, patients with undeveloped teeth, and the presence of metal artifacts. The power and sample size software, as well as the calculation formula, were used to determine the sample size:

$n = Z^2 \times r / d^2$

(To investigate the prevalence of a trait in the community). Considering α = 0.05, and 80% power, the incisive canal detection rate of 72% (according to the Parnia study) (15) and 10% error was estimated in 125 samples. A total of 125 images were obtained with a 3Dmid CBCT Planmeca device with a field of view of 8 * 10 from a private clinic of those patients who had been referred for various reasons, were over the age of 15, and whose files were available. The data collection was done by reviewing the records and radiographs of the patients, and the data collection was done from a checklist prepared for this purpose.

The checklist included demographic information, CBCT radiographs, and more. The CBCT data were entered into ROMEXIS software, and the images were displayed on a 19-inch LCD monitor with a resolution of 1208 x 1024 and 32 bits (PHILIPS (190B). The images were displayed in a semi-dark room.

The landmarks to be measured are (16):

1. MIC to the root tip of the canine and premolars: From the inside of the upper cortex border, MIC extends to the root tip of the first premolar and canine.

2. MIC to the lower cortex: From the inside of the lower cortex border, MIC to the outer part of the mandibular lower cortex border.

3. MIC to the buccal plate: from the inner side of the buccal side of the MIC cortex border to the outer side of the buccal plate.

4. MIC to the lingual plate: The distance from the MIC to the inner lingual cortex

5. Channel diameter: The maximum distance between the inner border of the canal cortex.

To measure the landmarks studied in the study, the two observers first examined 16 images, and then an agreement was reached between them. If the agreement is acceptable (agreement coefficient above 0.7), the continuation of the research was done by one observer. The information obtained by the observer was recorded on a checklist (measurements were in millimeters to the nearest tenth of a millimeter). The dissertation process was performed under the supervision of a radiologist in the department through complete training of all stages of CBCT imaging. The central, and dispersion indicators, and statistical tables were used to describe the data. The t-test (normal data distribution) or Mann-Whitney test (non-normal distribution) were used to analyze the data in men and women. SPSS.19 software was used to analyze the data.

Results & Discussion

Table 1: Determining the frequency of presence (detectability) of the mandibular incisive canal by CBCT.

	Number of study participants	Number of channels viewed
Female	69 (55.2%)	62 (89%)
male	56 (44.8%)	51 (91%)
total	125 (100%)	113 (90%)

According to Table 1, the presence (detectability) of the mandibular incisive canal by CBCT in female patients was 62 out of 69 patients (89%), and in male patients it was 51 out of 56 patients (91%). In all patients, the canal was observed in 90% of cases (113 patients out of 125).

Table 2: Determination of mandibular incisive canal diameter by CBCT.

	Gender	mean	Standard deviation	p-value
Incisive mandibular right channel	Male	1.8071	.32128	0.011
	Female	1.6609	.31117	
	total	1.7264	.32283	
Incisional left mandibular canal	Male	1.8429	.30681	0.045
	Female	1.7391	.26636	
	total	1.7856	.28869	

According to Table 2, the diameter of the incisive canal of the mandible by CBCT in the right mandible was 1.72±0.32 mm, which was significantly different between female and male patients (P = 0.011). Consequently, in male patients it was 1.80±0.32 mm and in female patients it was 1.66± 0.31mm; and the diameter of the incisive canal of the mandible by the left CBCT was 1.78±0.28 mm, which again there was a significant difference between female and male patients

(P = 0.045). So that in male patients it was 0.30 1.84±mm and in female patients it was 1.73±0.26 mm.

In general, the minimum measured diameter was 1 mm and the maximum measured diameter was 2.8 mm.

Table 3: CBCT measurement of mandibular incisive canal distance to canine and premolar root tips.

Root tip of right canine tooth	Male	6.4196	2.56943	0.001
	Female	5.0362	1.86026	
	total	5.6560	2.30285	
Root tip of left canine tooth	Male	6.3464	2.60188	0.003
	Female	5.0957	1.95707	
	total	5.6560	2.34374	
Right premolar	Male	7.2304	2.56791	0.000
	Female	5.5464	1.88949	
	total	6.3008	2.36423	
Left premolar	Male	7.4161	2.49201	0.000
	Female	5.7768	1.80768	
	total	6.5112	2.28393	

According to Table 3, the distance from the incisive canal of the mandible to the root canal of the right canine by CBCT was 5.65 ± 2.30 mm, which was significantly different between female and male patients (P <0.05), so that in men, it was 6.41±2.56 mm and in women, it was 5.03± 1.86 mm. The distance between the incisive canal and the root canal of the left canine measured by CBCT was 5.65 ±2.34 mm, which was significantly different between women and men (P <0.05) so that in men, it was 6.34 ±2.60 mm and in women, it was 5.09 ±1.95 mm. Moreover, the distance between the incisive mandibular canal and the tip of the premolar root measured by CBCT was 6.30 ±2.36 mm, which was significantly different between women and men (P <0.05), so that in men, it was 7.23 ± 2.56 and in women, it was 5.54 ±1.88 mm. The distance between the incisive mandibular canal and the tip of the left premolar root measured by CBCT was 6.51 ±2.28 mm, which was significantly different between women and men (P <0.05), so that in men, it was 7.41 ± 2.49 And in women, it was 5.77 ±1.80 mm.

In general, the minimum distance measured to the root tip of the right and left canine teeth was 1 and 1.4 mm, respectively, and the maximum distance was 13.4 and 13.2 mm, respectively. In general, the minimum distance measured to the root tip of the right and left premolars was 1.4 and 2 mm, respectively, and the maximum distance was 14.6 and 13.6 mm, respectively.

Table 4: Distance of mandibular incisive canal to inferior cortex by CBCT.

	Gender	mean	Standard deviation	p-value
Right lower cortex	Male	9.4232	1.89074	0.031
	Female	8.7420	1.59847	
	total	9.0472	1.76139	
left lower cortex	Male	9.5429	1.81578	0.014
	Female	8.8232	1.39644	
	total	9.1456	1.63122	

According to Table 4, the distance between the mandibular incisive canal and the right lower cortex by CBCT was 9.04 ±1.76 mm, which showed a significant difference between the sexes (P <0.05), and the distance from the mandibular incisive canal to the left lower cortex by CBCT was 9.14 ± 1.63 mm which showed a significant difference between men and women (P <0.05). The distance from the mandibular incisive canal to the right and left lower cortex is shorter in women than in men. The minimum distances in the right and left cortex were 5.80 and 5.60, respectively, and the maximums were 16.40 and 13.40 mm, respectively.

Acceptable resolution contrast, high measurement accuracy, and excellent CBCT image quality, as well as the low dose of patient radiation received, indicate the importance of examining the position of the incisive canal using CBCT (1).

Due to the importance of identifying the location of the incisive canal before placing intraosseous implants and maxillofacial surgeries in the anterior mandible, such as symphysis bone removal, and in order to prevent complications and disorders after surgery in this area, appropriate imaging techniques should be used. The present study showed that the mandibular incisive canal was detectable by CBCT in 62 out of 69 female patients (89%), and in 51 out of 56 male patients (91%). Parnia et al. (2011) (15) examined anatomical landmarks located in the inter foraminal region of the mandible by CBCT. According to the results, the incisive canal was detected in 71.9% of cases, of which 39.6% had good resolution. The results of this study were slightly lower than those of the present study, which showed that the incisive canal was detectable in 89% of women and 91% of men. In 1999, Calgaro et al. (17) were able to find the incisive canal in a large number of patients using 60 reconstructed CT images of the anterior mandible (41.6% on the left, 51.6% on the right), which was slightly lower than the results obtained from the present study. This discrepancy may be due to the use of CT in that study and CBCT in our study, some imaging limitations, the presence of image artifacts, the degree of cortical wall cortex, or a combination of them. Findings of Niknami et al.'s study (18) showed that in 89.9% of cases, incisive canals can be detected, which is in line with the percentage of canal detection in the present study. The study by Makris et al. showed that the incisive canal with CBCT is detectable in 91% of cases, and clearly visible in 83.5% (19). The findings of this study were also consistent with the results reported by Tepper et al. (20). The findings of this study were also consistent with the findings of Liang et al. (21). In the study of Pires et al. (3), 83% of the mandibular incisive canal can be detected in CBCT, which is slightly lower than in the present study. The study by Abbasi et al. (22) showed that in 79% of the images, the inferior branch of the inferior alveolar nerve is visible. Statistical differences in the visibility of these channels can be attributed to factors such as radiologist experience, patients' racial differences, and the quality of CBCT images. Jacobs also reported that the incisive canal was visible in 94% of cases with spiral CT (23). Pires et al. showed that all MIC parameters can be detected by CBCT imaging. In a study by Pires et al. (3), the MIC diameter ranged from 0.4 mm to 4.6 mm. The range in our studies was from 1 to 2.8 mm. Yufchev et al. (10) concluded that the diameter of MICs in men is larger than in women, which is in line with the present study. In our study, the average canal diameter was 1.8 mm in men and 1.66 mm in women.

Many studies have been performed to show the incisive canal and mental hole using CT and 2D imaging, but less effort has been made to examine this structure using CBCT. This study was performed to determine the presence and location of the mandibular incisive canal. Due to the lack of clear vision of the incisive channel and the study of the position of this channel in 2D imaging, in this study we used CBCT as the superior method to see and determine the position of the incisive channel. In 2020, Ramaswamy et al. (2020) in evaluating the mandibular incisive canal (MIC) and its relationship with adjacent landmarks using CBCT in 50 patients aged 20 to 70 years, showed a significant relationship between the incisive canal of the mandible and the root tip of the canine, the end of the cortex, and the buccal cortex. Also, the diameter of the incisive canal is larger in men compared to women and on the left compared to the right. The results of this study are consistent with the present study, which states that the diameter of the right and left incisive canal in men is (1.80 ±0.312 and 1.84 ±0.30), respectively. In Apostolakis and Brown et al., they concluded that the distance between the incisive canal of the mandible and the buccal plate was 4.62 ±1.41 mm, which is slightly higher than in the present study (24).

Malusare et al. (2019) in a retrospective study determining the dimensions of the mandibular incisive canal with landmarks adjacent to the CBCT in the Indian population showed that the canal length is 13.4 mm on the right and 12.4 mm on the left. We also compared Mc Donnell (1994) (13, 25) with the results of studies using CT and CBCT to examine the incisive canal with other studies using periapical, panoramic, and conventional tomographic films. This suggests that CT and CBCT imaging show anatomical structures more clearly than periapical films and panoramic radiographs. Of course, the use of CBCT is preferable to CT due to the lower radiation dose and also the lower price, and due to the smaller field of view in CBCT than in CT, it is more likely to see more details.

Conclusion:

As mentioned earlier, one of the most important anatomical landmarks that has always been challenged is the mandibular incisive canal, which has been described as one of the terminal branches of the inferior alveolar nerve and can be identified as a channel with well-defined boundaries in the mandibular bone. It should be considered because of the potential for hemorrhage and nerve damage such as traumatic neuroma. Therefore, its exact position and direction should be examined before any surgical intervention in the anterior mandibular region by appropriate imaging methods. In the present study, the distance from the canal to the buccal cortex is less than the lingual cortex, so it is better to pay more attention to the buccal cortex during surgery due to the proximity of the canal.

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