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ORIGINAL ARTICLE

Assessment of the position and level of mental nerve for placement of implants using cone-beam computed tomography & panoramic radiograph in the Saudi population

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KEYWORDS

Inferior alveolar nerve;
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Panoramic radiograph;
CBCT

Abstract *Background and objective:* In surgical dentistry, shape, location, position, and extent of the anterior loop of mental foramen plays a deliberately imperative landmark during an osteotomy procedure. To evade any neurological disturbance during implant surgery radiological assessment is compulsory. Therefore, the aim of the study was to assess the position and level of mental nerve for placement of implants using Cone-beam computed tomography & Panoramic radiography in the Saudi population.

Materials and methods: A total of 150 CBCT and Panoramic radiographs were taken from the patients who visited the Department of Oral Medicine and Radiology. The data collection was done by using the same radiographic pieces of equipment for both CBCT and Panoramic radiographs. CBCT images taken from Kodak 9000 3D, Carestream Health, Inc., New York, USA, and Panoramic Radiographs taken from Panoramic Planmeca ProMax, Helsinki, Finland (Vujanovic-Eskenazi et al., 2015). The Chi-square test student test was used for statistical analysis.

Results: The most frequent shape and location of mental foramen in both CBCT and Panoramic radiographs were oval and in between the first and second premolar, both in CBCT & PR views. The visibility of mental loop on CBCT & PR view showed that; visibility of mental loop in CBCT was higher with 42(56%) as compared with PR view 26(34.66%) with statistically significant p-value 0.014. The mean length of the mental loop on CBCT was statistically significant ($p = 0.001$). But the mean distance from the lower point of the mental foramen to the lower border of the mandible was not statistically significant.

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Conclusion: Based on the results of the present study; the visibility of the mental loop and its extension is more in CBCT as compared with PR views. Therefore, we recommended CBCT, during of implant surgery.

1. Introduction

The inferior alveolar nerve is the branch of a mandibular nerve that enters into the mandible through the mandibular foramen, continuously runs in the mandibular canal, and ends at the mental foramen (Pereira-Maciel P et al.,2015). The mental foramen situated on the buccal cortex of the body of mandible at anterolateral aspect, from where the inferior alveolar nerve and artery, traveled via an inferior dental canal, and after exit gives mental and nerves and vessels (Haghanifar S et al.,2009). The mental nerve is one of the quintessence terminal branches of the inferior alveolar nerve, that come out from the mental formina and supplies to the lower jaw starting from the medial border of the masseter muscle to midline of skin and mucous membrane of the buccal vestibule (Kieser et al., 2002).Anatomical landmarks of the mandible including location, type, and course of its neurovascular bundle play a vital role in gaining local anesthesia and any surgical measures (Von Arx et al., 2013). Dental implants are habitually positioned in the posterior part of the mandible, to create fixed restorative prostheses. The compromised and atrophied quality of bone encountered from anterior to posterior directions in such cases that suitable extended fixed prostheses are difficult to deliver without infringing the inferior alveolar nerve (Kan et al., 1997). Implant placement at mandibular premolar region unintentionally associated with neurosensory variations at the chin and lower lip during a surgical procedure. This complication is more common when the structure, location of certain vital identities like mental foramen and anterior mental loop are not properly recognized and confined (Juodzbalys G et al., 2010). Therefore, to evade this distress a 5 mm safe distance from mental foramen has been proposed for implant surgery (Hunt and Jovanovic, 1999). Fig. 1.

Consequently, to preserve these vitals; identification of an exact location of the mental nerve along with other structures should be indispensable by using apt radiographic techniques. The Panoramic radiograph and CBCT both are characteristically used to identify the position of anatomic landmarks in implant placement. Although Panoramic radiography along with clinical examination is frequently used as a preoperative diagnostic measure in implant surgery, even with its low magnification and distortion of the image, especially in the anterior region (Kuzmanovic et al., 2003; Yim et al., 2011). In such a situation CBCT emerges as a new diagnostic tool to improve the quality of images. Thus, the present study endeavored to assess the position and level of mental nerve for placement of implants using panoramic radiograph & cone-beam computed tomography in the Saudi population.

2. Materials and methods

2.1. Study design

A comparative observational study was conducted in the Department of Oral Medicine and Radiology, College of Dentistry, King Khalid University and Ethical clearance was obtained from Scientific Research Committee and Informed consent was taken from all the study participants. ***2**.2 Sample size & Sampling*.

The method of sampling was convenient sampling, patients visited in the department of Maxillofacial Radiology at College of Dentistry, King Khalid University for their dental treatment from the duration between December 2021 to February 2022 were included, As 150 participants (75 male and 75 female), were selected and CBCT and PR were taken.

2.2. Inclusion & exclusion criteria

Patients aged more than 18 years with complete skeletal growth were included and patients below the age of 18 years with pathologic lesions and a history of orthodontic treatment were excluded.

2.3. Data collection

The standard viewing, appropriate brightness, and contrast were used for data collection. To minimize the bias all data collection was done by two examiners and after discussion, final interpretation was done. The same radiographic pieces of equipment were used for both CBCT and Panoramic radiographs. CBCT images taken from Kodak 9000 3D, Carestream Health, Inc., New York, USA and Panoramic Radiographs taken from Panoramic Planmeca ProMax, Helsinki, Finland (Vujanovic-Eskenazi A et al., 2015).

Tangential, cross-sectional, and axial view plans were used to analyze all Cone Beam Computed Tomography (CBCT) projections. The cross-sectional and axial views were used for the detection of the mental foramen, then tangential projections were utilized to identify the shape of mental foramen as round and oval, and irregular (Fabian, 2007). Whereas the anterior-posterior or horizontal position of mental foramen in CBCT image was identified according to Yosue and Brooks (1989).

The shape of the mental foramen in panoramic radiographs was recorded by creating the drawing ruler in the software to outline the exterior periphery of a piece of mental foramen (Al-Shayyab et al., 2015) and the shape of mental foramen appreciated as round, oval or irregular. The anterior-posterior position or horizontal position of mental foramen

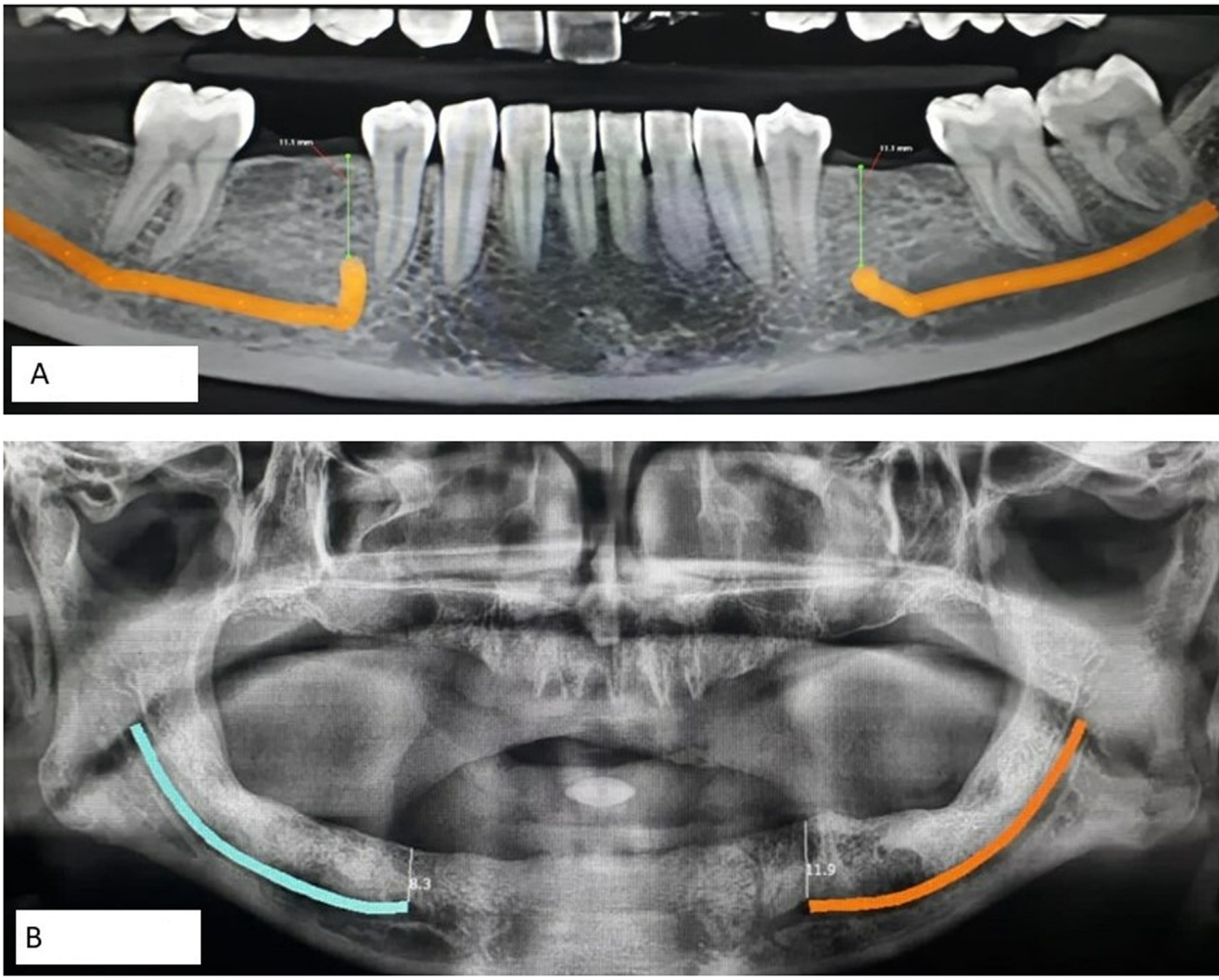

Fig. 1 Measurement of Mental loop A) PR view, B) CBCT.

in Panoramic reflection was recorded as per Al Khateeb et al., 2007; Haghanifar & Rokouei, 2009. The interpretation of the anterior-posterior or horizontal position of mental foramen followed in both Panoramic and CBCT are: (Al-Khateeb et al., 1994; Haghanifar S et al., 2009).

Position 1: situated anterior to the first premolar.
Position 2: in line with the first premolar.
Position 3: between the first and second premolars.
Position 4: in line with the second premolar.
Position 5: between the second premolar and first molar.
Position 6: in line with the first molar.

The measurements of a mental loop (distance from the lower border of the mandible to the lower point of the mental foramen) and its extension were done by using a measurement tool provided by each software as per Kuzmanovic et al (Kuzmanovic DV et al., 2003). It is shown in figure 1 and 2.

2.4. Statistical analysis

The data were entered into excel sheets scrutinized by the statistical package for social sciences (SPSS) (version 22, SPSS Inc., Chicago, IL) with the level of significance at 0.05. Data presentation was performed as frequency distribution tables. Chi-square test student test was to performed statistical analysis.

3. Results

3.1. Mental foramen shape

The shape of mental foramen on the right side of CBCT illustrated that; 55 (73.33%) were oval, 20 (26.66%) round whereas in PR; were 50 (66.66%) oval, 21 (28%) were round, and 04 (5.33%) were irregular. The shape of mental foramen on the left side of CBCT showed that; 57 (76%) were oval, 18 (24%) were round whereas in PR 52 (69.33%) were oval, 19 (25.33%) were round, and 04 (5.33%) were irregular. The shape of mental foramen in right and left sides was not statistically significant in CBCT and PR as shown in Table 1.

3.2. Position of mental foramen of right side

The position of the right side of mental foramen in Cone Beam Computed Tomography (CBCT), exemplified that 36 (48%) located in between the first and second premolar, 33 (44%) situated in line with the second premolar, 04 (5.33%) situated between the second premolar & first molar and only 02 (2.66%) situated in line with the first molar. Whereas the position of mental foramen in PR was; 39(52%) located between the first and second premolar, 32(42.66%) in line with the sec-

Table 1 Mental foramen shape on right and left side in Cone Beam Computed Tomography (CBCT) & Panoramic Radiographic (PR) views.

	Right Side Shape			p value	Left Side Shape			p value
	Round	**Oval**	**Irregular**		**Round**	**Oval**	**Irregular**	
CBCT	20 (26.66%)	55 (73.33%)	0	0.119	18 (24%)	57 (76%)	0	0.119
Panoramic	21 (28%)	50 (66.66%)	04 (5.33%)		19 (25.33%)	52 (69.33%)	04 (5.33%)	

Note:-Results are presented as frequency distribution and Chi-square test was applied. P value < 0.005 consider significant.

Table 2 Position of mental foramen of right side in Cone Beam Computed Tomography (CBCT) & Panoramic Radiographic (PR) views.

	Position of Mental foramen (Right Side)						p value
	Anterior to first premolar	**In line with the first premolar**	**Between the first and second premolar**	**In line with second premolar**	**Between the second premolar & first molar**	**In line with the first molar**	
CBCT	0	0	36 (48%)	33 (44%)	04 (5.33%)	02 (2.66%)	0.894
Panoramic	0	0	39 (52%)	32 (42.66%)	03 (4%)	01 (1.33%)	

Note:-Results are presented as frequency distribution and Chi-square test was applied. P value < 0.005 consider significant.

ond premolar, 03(4%) in Between the second premolar & first molar, and merely 01(1.33%) placed in line with the first molar. The position (right side) mental foramen in CBCT & PR was not statistically significant as shown in Table 2.

3.3. Position of mental foramen of left side

The position of the left side of mental foramen in Cone Beam Computed Tomography (CBCT), exemplified that 38(50.66%) positioned in between the first and second premolar, 27(36%) situated in line with the second premolar, 07(9.33%) situated between the second premolar & first molar, 02(2.66%) situated in line with the first molar and only 01(1.33%) located anterior to the first premolar. Whereas the position of mental foramen in PR was; 36(48%) located between the first and second premolar, 33(44%) in line with second premolar, 03(4%) in Between the second premolar & first molar, merely 02 (2.66%) placed in line with the first molar and 01(1.33%) situated anterior to the first premolar. The position (left side) mental foramen in CBCT & PR was not statistically significant as shown in Table 3.

3.4. Mental loop visibility

The visibility of mental loop on CBCT & PR view showed that; visibility of mental loop in CBCT was higher with 42 (56%) as compared with PR view 26(34.66%) with statistically significant p-value 0.014. It has been shown in Table 4.

3.5. Mean values of deviation of the mental loop (ML)

The mean length of the mental loop on CBCT was 1.609 mm with 0.861 SD and on PR was 2.56 mm7 with 0.881SD. The difference between the mean length of a mental loop in CBCT and PR was statistically significant ($p = 0.001$). The mean distance from the lower point of the mental foramen to the lower border of the mandible was 11.537 mm in CBCT and

Table 3 Position of mental foramen of right side in Cone Beam Computed Tomography (CBCT) & Panoramic Radiographic (PR) views.

	Position of Mental foramen (Left Side)						p value
	Anterior to first premolar	**In line with the first premolar**	**Between the first and second premolar**	**In line with second premolar**	**Between the second premolar & first molar**	**In line with the first molar**	
CBCT	01(1.33%)	0	38(50.66%)	27(36%)	07(9.33%)	02(2.66%)	
Panoramic	01(1.33%)	0	36(48%)	33(44%)	03(4%)	02(2.66%)	0.689

Note:-Results are presented as frequency distribution and Chi-square test was applied. P value < 0.005 consider significant.

Table 4 Mental loop visibility on Cone Beam Computed Tomography (CBCT) & Panoramic Radiographic (PR) View.

	Visibility		p value
	Visible	**Not Visible**	
CBCT	42(56%)	33(44%)	0.014
Panoramic	26(34.66%)	49(65.33%)	

Note:-Results are presented as frequency distribution and Chi-square test was applied. P value < 0.005 consider significant.

Table 5 Mean values of deviation of the mental loop (ML) and the distance of the mental foramen (MF) and the lower border of the mandible on panoramic radiographies (PR) and cone beam computed tomography (CBCT).

	Mean ± SD	p value
Mental loop on CBCT	1.609 ± 0.861	
Mental loop on Panoramic	2.567 ± 0.881	0.001
Distance between ML and basilar mandible on CBCT	11.537 ± 2.677	
Distance between ML and basilar mandible on PR	11.68 ± 2.288	0.724

Note:-Results are presented as Mean and Standard Deviation and Student-*t* test was applied. P value < 0.005 consider significant.

11.68 mm in PR, but the p-value was not statistically significant as shown in Table 5.

4. Discussion

In surgical dentistry, the mental foramen plays a deliberately imperative landmark during an osteotomy procedure. Its shape, location, position, and extent of the anterior loop need to be considered before any implant surgery to avoid the injury at the mental nerve. To evade any neurological disturbance in the interforaminal region, during implant surgery radiological assessment is compulsory. Even though 2-D imaging techniques are not very reliable during surgical osteotomy in the anterior mandible, they were used earlier even in the current scenario (Vujanovic-Eskenazi A et al., 2015) therefore the present study was conducted to assess the position and level of mental nerve for placement of implants using Cone-beam computed tomography & Panoramic radiography in Saudi population.

4.1. Mental foramen shape-

The present study revealed that the most common shape of mental foramen in both CBCT & PR was ovally trailed by round. The irregular shape of mental foramen is found only in PR views. Our results are analogous with Sheikhi M et.al; in their study, the frequency of oval images was 69.4% and round was 30.6% in CBCT (Sheikhi et al., 2015). Several studies reported that the shape of mental foramen is mainly of two types; oval and round. When we compared according to races the majority of Indians were reported to have round mental foramen. The frequencies of oval and round shape of mental foramen in equal percentages have also been reported in Tanzanian and Zimbabwean populations (F. M. Fabian et al., 2007; Al-Juboori et al., 2014).

4.2. Mental foramen location-

During implant placement, it is extremely important to locate the mental foramen to avoid common complications affecting the mental nerve. In the present study the most frequent location of mental foramen is between the first and second premolar followed by in line with the second premolar, only a few were located between the second premolar & first molar and in line with the first molar. Almost similar results found by Velasco-Torres M et al; between the first and second premolars (33.33%) is the most repeated location of the mental foramen, then 21.41% situated mesial to the second premolar, 18.65% distal to the first premolar, 17.74% apical to the second premolar and merely 7.03% located apical to the first premolar (Velasco-Torres et al., 2017).

4.3. Mental loop

In our study, the visibility of mental loop in Panoramic view was 26(34.66%) whereas in CBCT was 42(56%). Similar results were found by Kaya Y et.al; the prevalence of the mental loop in panoramic radiographic view and spiral CT images was 28% and 34%, correspondingly (Kaya et al., 2008). According to various studies; recognition of the incidence or coverage of mental loop is not accurately achieved by panoramic radiographs (Kuzmanovic DV et al., 2003; Kaya Y et al., 2008) and very similar results found in our study. It shows the visibility of mental foramen is higher in CBCT as compared with PR. In this study, the mean length of the mental loop on CBCT was 1.609 mm with 0.861 SD and on PR was 2.56 mm7 with 0.881SD. And the mean distance from the lower point of the mental foramen to the lower border of the mandible was 11.537 mm in CBCT and 11.68 mm in PR. Whereas a study by Vujanovic-Eskenazi A et.al; found the mean length of the anterior loop was 1.59 mm in CBCT and 2.82 mm in PR (Vujanovic-Eskenazi A et al., 2015). However, Wismeijer et.al; found that 7% sensory loss was found in the lower lip even after taking 3 mm safety margins during implant placement (Wismeijer et al., 1997). The measurement of the extension of the mental loop is compulsory because it has been proven that; when only mental foramen is used as a guide without a formative assessment of its the anterior loop may results in the placement of implants too far from mesial to the mental foramen or purely infringe the mental nerve (Demir et al., 2015).

According to this study identification of anatomical landmarks are very essential before planning any surgical intervention. Benavides et.al; also said that the superiority of image is more important as compared with the clinician's diagnostic ability (Benavides et al., 2012). Therefore we recommended CBCT, during scheduling of implant surgery, especially in the anterior region of the mandible to minimize the risk of injury in foramen region.

5. Conclusion

Based on the result of the present study; the visibility of the mental loop and its extension is more in CBCT as compared with PR views. Therefore we recommended CBCT, during scheduling of implant surgery, especially in the anterior region of the mandible to minimize the risk of injury in interforaminal region. In the end, the study concluded that preoperative detailed clinical, as well as a radiological examination of the course of IAN, mental foramen, and mental nerve, is obligatory during any surgical intervention. A study with a larger sample size should also recommend creating more strong evidence with regard to safety margins.

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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