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Radiographic Evaluation of the Anterior Loop of the Mental Nerve: Comparison between Orthopantomograph and Cone-Beam C T – A pilot study.

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ABSTRACT

Damage to the mandibular nerve due to improper understanding of the anatomical location and its course may lead to neurosensory disturbances during implant placement. The mental canal which rises from the mandibular canal and runs outward, upward and backward to open at the mental foramen is an anatomical variation called anterior loop. Prevalence of the anterior loop is quite variable in literature, ranging from 28%-71% and its length as little as 0.5 mm to as much as 10mm. A cross-sectional study was done in patients with OPG and CBCT. A total sample of 99 OPG's and CBCT's was evaluated. Within the limitations of the study, we concluded that the visualization of the anterior loop in OPG was 71.7% and 78.8% on the left and right sides respectively. CBCT has 100% visualization of the anterior loop on both the sides in our population. The mean length of the anterior loop on the right side in the OPG and CBCT is 3.08 ± 0.94 and 2.87 ± 0.81 respectively and 2.66 ± 0.90, 2.93 ± 0.84 respectively for the left side. A high correlation was found between OPG and CBCT in identification and measurement of lengths on right and left sides.
Keywords: Cone beam computed tomography, Orthopantomograph, Anterior loop of mental nerve, Implant.

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INTRODUCTION

Dental Implantology is on an upward evolution, being an alternative to prosthetic solutions. The success rates of implant surgery are being reported to be as high as 97% [1]. In spite of the success rates, nerve damage leading to neurosensory disturbances have been reported due to improper understanding of the anatomical location and course of the mandibular nerve.

The mental canal which rises from the mandibular canal and runs outward, upward and backward to open at the mental foramen is an anatomical variation called anterior loop. Prevalence of the anterior loop is quite variable in literature, occurring in between the range of 28% [2] and 71% [3] and the reported length of the anterior loop ranged as little as 0.5 mm in some patients [4] and as much as 10mm in others [5].

Neurosensory disturbances of the chin and lower lip are among the most frequent accidental complications during implant placements, often due to failure to identify and estimate the extension of the anterior loop. Complications of loss of lip and chin sensation may result in lip biting, impaired speech, and diminished salivary retention, deficits that have a significant impact on a patient's activities of daily living. To avoid such a situation, a 5-mm safe distance to the most distal fixture from the anterior loop [6] and a 5-mm distance from the mental foramen for chin bone harvesting have been proposed [7].

Even though these general safety margins do exist, the problem relates to the ability of the surgeon to identify the anterior loop preoperatively or even intra-operatively to safely plan his actions, thus avoiding the risk during implant placement. Lack of explicit definitions and standardized methods to assess their extension justifies revisiting the features of anterior loops.

Consequently, the use of appropriate imaging techniques is important in identifying the exact location of the mental foramen and anterior loop structures when a dental implant is installed into the premolar and molar regions. Orthopantomography (OPG) is the most commonly used radiographic imaging modality in planning for placements of endosseous implants. However, investigations that compared OPG images and cadaveric dissections reported a high incidence of false negatives and false positives with respect to identifying the anterior loop. Because of this variability, various authors have suggested that OPGs have limited applications in implant treatment planning [8].

Cone-beam computed tomography (CBCT) is a relatively new imaging modality which provides multiplanar views of the facial skeleton with a reduced radiation dose, compared to conventional CT. CBCT has been shown superior to panoramic radiographs in displaying the mandibular canal and its variations. It was shown that there was no statistically significant difference between anatomical cadaveric measurements and measurements derived from CBCT [6]. This being said, the availability of CBCT is not a widely available option for most practitioners, whereas OPGs are fairly common.

The aim of the present study is to know the prevalence, identification and length of the anterior loop in OPG and to correlate the findings with CBCT.

The following specific objectives were formulated.

1. To determine the prevalence and length of the anterior loop in both OPG and CBCT
2. To compare the reliability of OPG findings to CBCT findings

METHODOLOGY

A cross-sectional study was done in which retrospective and prospective data were evaluated. Patients who got their OPG and CBCT taken for any reason which showed the mental foramina were included in the study. Radiographs which are not clear were excluded. Screening of the archives was done from November 2011-2014 September and a total of 84 radiographs were identified from the archives. 15 patients who got their OPG and CBCT done during the study period were also included. A total sample of 99 OPG's and CBCT's were evaluated by two calibrated examiners who followed a standard operating procedure and

collected data independently and in duplicate. Inter-observer variability between the two examiners was calculated after 30 radiographic measurements. (R=0.8 – indicating high strength of agreement).

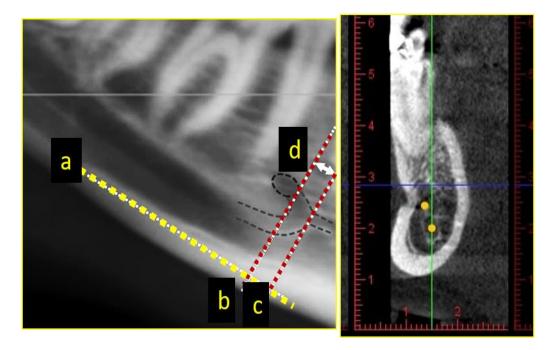**Identification of anterior loop and measurement in CBCT [9]:**

Figure 1: Lines for measurement of anterior loop in Orthopantomograph
Figure 2: 2 mm section of CBCT image showing anterior loop in the figure of "8" shape

Panoramic reconstruction and cross-sections were used in the identification of anterior loop. (Fig 1) In the panoramic reconstruction, line (a) was drawn following the inferior border of the mandible. Two lines (b) and (c) were drawn perpendicular to (a). Line (b) was related to the anterior border of the mental foramen and line (c) related to the anterior border of the anterior loop. The distance between (a) and (b) represented the length of the anterior loop (d) (Figure 1). To visualize the entire course of the canal the slice thickness from 5 to 20mm were used. For the cross-sections, the anterior loop was determined by counting the number of sequential 1 mm slices displaying two round hypodense images (ending in an "8-like" shape anteriorly), from the anterior-most image of the mental foramen and start point of the incisive canal (Figure 2). Hence, measurements on panoramic reconstructions presented inferior mandibular border as a reference, while occlusal plane served as a reference on cross-sections.

Identification of anterior loop and measurement in OPG:

The mental foramen was first identified by the method suggested by Yosue and Brook [10], and then the presence or absence of anterior loop was identified. This was followed by measuring the length of the anterior loop as described for CBCT.

RESULTS

The mean age group of the 99 participants included in the study was 44.5 years. 36.4% of the participants were Malays (13 Males, 23 Female), 44.4% were Chinese (18 Males, 26 Females) and 19.2% were Indians (12 Males, 7 Females) (Table 1).

With CBCT, anterior loop was seen in 23.2% of the records and was absent in 76.8% on the left side. On the right side it was seen in 37.4% absent in 76.8% of the records (Table 2).

Table 1: Socio-demographic Profile

Race	Gender		Age (years)		
	Male	Female	Min. age	Max. age	Avg. age
Malay	13	23	21	70	45.5
Chinese	18	26	17	72	44.5
Indian	12	7	22	65	43.5

Table 2: Descriptive analysis for the presence or absence of anterior loop in OPG and CBCT on right and left sides

LEFT		CBCT		Total
		Yes	no	
OPG	Unable to see	8	20	28
	Yes	13	1	14
	No	2	55	57
Total		23	76	99
RIGHT		CBCT		Total
		Yes	no	
OPG	Unable to see	10	11	21
	Yes	26	1	27
	No	1	50	51
Total		37	62	99

Table 3: Mean values with standard deviation for the length of anterior loop on the right and left sides in OPG and CBCT

		Age	Left		Right	
			OPG(mm)	CBCT(mm)	OPG(mm)	CBCT(mm)
N	Valid	99	14	21	27	37
	Missing	0	85	78	72	62
Mean		47.3131	2.9314	2.6638	3.0781	2.8684
Median		50.0000	2.8350	2.5700	3.1000	2.8800
Std. deviation		13.72667	.89801	.83762	.93687	.80935
Minimum		17.00	1.23	1.22	1.22	1.22
Maximum		72.00	4.80	4.30	5.67	5.30

Table 4: Pearson's correlation between the length measurements in OPG and CBCT on the left and right side

LEFT		OPG (mm)	CBCT (mm)
OPG (mm)	Pearson Correlation	1	.963**
	Sig. (2-tailed)		< .001
	N	14	14
CBCT (mm)	Pearson Correlation	.963**	1
	Sig. (2 tailed)	< .001	
	N	14	21
RIGHT		OPG (mm)	CBCT (mm)
OPG (mm)	Pearson Correlation	1	.986**
	Sig. (2-tailed)		< .001
	N	37	27
CBCT (mm)	Pearson Correlation	.986**	1
Sig. (2 tailed)		< .001	
N		27	27

With OPG anterior loop was seen in 14.1% of the records, absent in 57.6% of the records but its presence could not be confirmed in 28.3% on the left side. On the right side, it was seen in 27.3% and absent in 51.5% of the records but its presence could not be confirmed in 21.2% (Table 2).

The mean length of the anterior loop as determined by CBCT was 2.66±0.84 mm and 2.87±0.81 mm for left and right respectively. In OPG it was 2.93±0.89 mm and 3.07±0.94 mm for left and right respectively (Table 3).

A strong positive correlation was found by Pearson's correlation 2-tailed test between the length of the measurements in OPG and CBCT with an r value of 0.963 and 0.986 for the left and right side respectively (Table 4).

DISCUSSION

Multiple studies have measured the length of the anterior loop of the inferior alveolar nerve, using anatomical, radiographically and combined methods [2,6,8]. These studies show that the panoramic radiographs do not accurately identify the incidence or the extent of the anterior loop [8, 11-14].

Wei Cheong Ngeow et al. reported that the anterior loop was present in 40.2% [14] for all subjects, whereas Arzourman et al. [13] and Kuzmanovic et al [8] reported a lower incidence at 12%, and 27% respectively. But our study showed that in 14 out of the 99 (14.14%) cases for left side and 27 out of 99 (27.3%) for right side, the anterior loop of the inferior alveolar canal was present in the OPG scans. The discrepancy in the incidence of visualization may be related to the use of different panoramic machines providing varying resolution of radiographs and a difference in the racial demographic of our sample. The previous studies did not mention the frequency in which the anterior loop presence could not be confirmed in their OPG scans. Our study found that in 28 out of the 99 cases (28.28%) for left and 21 out of 99 cases (21.21%) for right, presence of anterior loop could not be visualized. This could be due to the disadvantage of image distortion in OPG scans. Radiographic distortion of the image may be due to the thinning of the focal through towards the anterior section in OPGs. The focal trough is a three-dimensional curved zone or image layer in which structures are well defined on panoramic radiographs. Only anatomic structures located within the focal trough are imaged properly. Objects falling outside the focal trough are blurred, magnified, or reduced in size. It should be noted that the size and relative shape of the focal through varies with the brand of equipment used [3].

Also, the interposition of the cervical spine towards the anterior region in the middle causes a large radiopaque region, it could potentially obscure the anterior loop and even up to the mental foramina in some cases where the patient does not sit straight and align or stretch the neck [15].

In relation to CBCT scans, our study found that the anterior loop was present in 23.23% and 37.4% of the 99 cases for left for right respectively, as compared to the 48% found by Apostolakis et al [11].

The absence or presence of the anterior loop could be seen clearly in every CBCT image scan we made compared to the 28.28% of OPG scans. This is because CBCT scans provide a higher resolution image as well as 3D visualization of the anatomic structures so that they can be traced more easily [3]. The anterior loop is an intramedullary structure located in an area where the cortical plates are relatively thick. As such, it would be virtually impossible to detect in plain films, and detection would be dependent on its relative position in the image layer in a panoramic radiograph [13]. The difficulties of identifying anatomic structures have also been attributed to poor radiographs, poor bone quality and the inability to distinguish these structures from the trabecular pattern [8].

Kuzmanovic et al. [8] reported that the mean length of the anterior loop was 1.20 mm, but Azourman et al.[13] reported a higher mean of 3.18 mm (Panelipse) and 3.45 mm (Orthoralix). Based on our study, the mean length of the anterior loop in OPG scans for our subjects was 2.93±0.89 mm and 3.07±0.94 mm for left and right respectively, which was in agreement to Azourman et al [13].

Whereas for CBCT measurements, Rosa et al. [16] found that the mean length was 2.4 mm. Judy Chia et al.[15] however, found that the mean length was 7.61mm and 6.22mm for Taiwanese and American subjects respectively. Additionally, Apostolakis et al. [11] found a mean of 0.89mm. The mean length of the anterior loop in our study for CBCT scans was 2.66±0.84 mm and 2.87±0.81 mm for left and right respectively. Our results are more in accordance with Rosa et al [16]. There appears to be a significant disparity in the mean lengths of the anterior loop in each individual's study. Again, this could be due largely to differences in the race, gender and age of the sample populations.

Taking only the measurements of our study for both OPG and CBCT into consideration, the mean lengths obtained appear to not differ much.

CONCLUSION

Within the limitations of the study, the following conclusions can be drawn:

- The visualization of the anterior loop in OPG was 71.7% and 78.8% on the left and right sides respectively. CBCT has 100% visualization of the anterior loop on both the sides in our population.
- The mean length of the anterior loop on the right side in the OPG and CBCT is 3.08 ± 0.94 and 2.87 ± 0.81 respectively and 2.66 ± 0.90, 2.93 ± 0.84 respectively on the left side.
- A high correlation was found in between OPG and CBCT in the identification and measurement of lengths on right and left sides.

CLINICAL IMPLICATION

- It depends on the clinical decision whether an OPG or CBCT are necessary for pre- implant assessment
- In straight forward cases, OPG can be used as a reliable diagnostic tool to do a pre-implant planning
- In crucial cases with minimal bone and more proximity of the implant to the foramen, a CBCT image can be of more value

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