

A Radiological Study on the Visualization of the Anterior Loop of Mandibular Canal Using Panoramic Radiography

Saritha Maloth*, Padmashree S.**, Pramod Krishna B.***

Abstract

Background: The anterior loop is a prolongation of the neurovascular bundle of mandibular canal anterior to the mental foramen. This structure cannot be seen clinically but can be detected in radiographs. It is an important presurgical landmark of the mental interforaminal area during radiographic analysis. *Aims:* To determine the visibility of anterior loop in the mandible on panoramic radiographs. *Material and Methods:* Total 480 Panoramic radiographs of dentate patients with completely erupted lower premolars and molars were selected for the study. Subjects were divided into five different age groups. The radiographs were assessed for visibility of anterior loop. Anterior loop status was categorized as present on both sides, present on right side only and present on left side only. *Statistical Analysis:* Cross tabulations followed by a chi-square test were performed to compare the significance of categorical findings with respect to age group and gender. A P-value of less than 0.05 was considered as statistically significant. *Results:* One or more anterior loops were visible in 41% of radiographs. Anterior loops were most commonly visible bilaterally in 29.2% of radiographs followed by right side 7.5% and left side 4.3%. Visibility of anterior loop reduced with increased age of the subjects. There was no association between visualization of the anterior loop and subject gender. *Conclusion:* In our present study, the radiographic appearance of anterior loop was present in significant percentage of cases. Prevalence of the anterior loop can be overlooked and should be carefully identified before any surgical procedures in the mental interforaminal region.

Keywords: Anterior Loop; Mental Foramen; Panoramic Radiographs.

Introduction

One of the common complications that can occur following surgical procedures in the mental interforaminal region of anterior mandible is neurosensory alterations in the chin and lower lip. This complication can occur if vital structures such as mental foramen and anterior mental loop are not properly identified and protected [1]. The mental nerve extends beyond the mental foramen boundary as intraosseous anterior loop that can be detected using appropriate radiographic techniques [2].

Author's Affiliation: *Associate Professor, Department of Dentistry, KIMS, Koppal, India **Professor and Head, Dept of Oral Medicine and Radiology, Vydehi institute of dental sciences, Bangalore, India. ***Professor, Dept of Oral and Maxillofacial surgery, Farooqia Dental College and Hospital, Mysore, India.

Reprints Requests: Saritha Maloth, Associate Professor, Department of Dentistry, Koppal institute of medical sciences, Koppal, Karnataka, India.

E-mail - saritha.maloth@gmail.com

Received on 06.02.2017, Accepted on 13.02.2017

Anterior loop is referred as the mental canal which rises from the mandibular canal and runs outwards, upwards and backwards to open at the mental foramen (Sichers oral anatomy) [3]. Very few studies have been undertaken to recognize anterior loop radiographically. Panoramic radiographs are routinely used to locate anatomical landmarks for planning surgical procedures in interforaminal regions to avoid post operative complications [4]. Hence this study was undertaken to determine the visibility of anterior loop in the mandible on digital panoramic radiographs and to determine the effect of aging and gender on visualization of the anterior loop on panoramic radiographs.

Materials and Methods

A total of 480 dental panoramic radiographs taken for routine diagnostic purposes in the department of Oral Medicine and Radiology were selected for the study. All panoramic radiographs

were taken using Planmeca machines. Only good Quality radiographs of dentate patients with completely erupted lower premolars and molars were selected for the study. The magnification factors reported by the manufacturers were 1.2 and 1.25 respectively. The planmeca X- ray machine was operated at 66 kvp, 10 ma for 13 sec. All the subjects or patients were divided into five different age groups as follows: 14-24 yrs, 25-35yrs, 36-46yrs, 47-57 yrs and 58 yrs and older. The radiographs were selected based on the following criteria.

1. High quality radiographs with respect to geometric accuracy and contrast of the image.
2. Teeth present between lower first molars on right and left side.
3. Radiographs with no deep caries, endodontically treated tooth or various large restorations in lower teeth.
4. Radiographs free from any radiolucent or radioopaque lesions in the lower arch / mandible and with no evidence of jaw fracture around the mental foramen and mandibular canal region.
5. Radiographs with no supernumerary unerupted teeth in the mental foramen region.
6. Radiographs devoid of any radiographic exposure or processing errors and artifacts.

The radiographs were placed on a well illuminated view box and viewed with a magnifying lens. The radiographs were interpreted independently by two observers and differences in the results were discussed and reabsorbed for conclusion. If there was any difference in the results then a third observer with experience in Oral Radiology would make the final evaluation. We first identified the mental foramen according to the description of Yosue and Brook [5] and then determined whether an anterior loop was present or absent. The typical appearance of the anterior loop on a dental panoramic radiograph is shown in Figure 1.

Anterior loop status was divided into four

categories such as

- I. Present on both sides
- II. Present on right side only
- III. Present on left side only
- IV. Absent

Data and Statistical Analysis

All calculations were processed using SPSS statistical software. Cross tabulations followed by a chi-square test were performed to compare the significance of categorical findings with respect to age group and gender. A P-value of less than 0.05 was considered as statistically significant.

Results

A total of 480 panoramic radiographs that fulfilled the criteria were selected. They were divided according to age group into five subgroups (Table 1). This study included 257 male and 223 female subjects and their distribution according to age groups is shown in Figure 2. Table 2 shows visibility of anterior loops according to age groups and subject gender. The number of subjects (and hence the radiographs) that fulfilled the criteria reduced as the age of subjects increased. At least one anterior loop was visualized in 41% of radiographs. Most of the anterior loops were visible bilaterally (29.2%) followed by on right side (7.5%) and only 4.3%. on left side It was not visible in 59% of cases. More than 30% of subjects aged 14-35yrs had bilaterally visible anterior loop and this gradually reduced to only 3.5% in subjects aged above 58yrs. It was more commonly identified in males (51%) than in females (49%). The anterior loop was most frequently visible bilaterally in both the gender. There was no significant difference in visibility of anterior loop by gender.

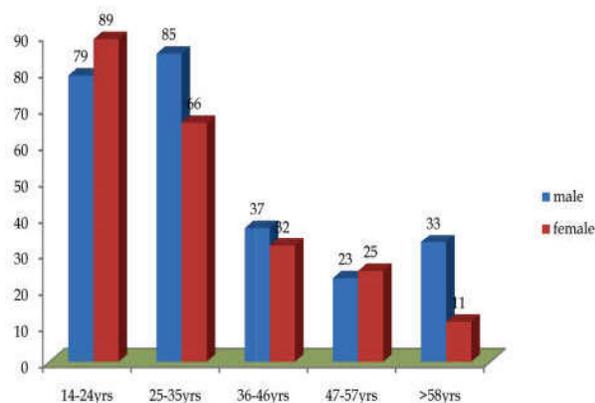
Table 1: Distribution of the number of subjects according to age groups

Age Group(yrs)	Number of subjects (Radiographs)	Percentage
14-24	168	35.00
25-35	151	31.46
36-46	69	14.38
47-57	48	10.00
>58	44	9.17
Total	480	100

Table 2: Visibility of anterior loops according to age groups and gender of the subjects on panoramic radiographs

Age Groups (yrs)	Gender (n)	Present (frequency)			Absent (frequency) (IV)
		Both side(I)	Right (II)	Left (III)	
14-24	F (89)	28	7	5	49
	M(79)	30	5	3	41
25-35	F(66)	24	3	4	35
	M(85)	27	4	3	51
36-46	F(32)	8	5	0	19
	M(37)	10	3	2	22
47-57	F(25)	4	4	2	15
	M(23)	5	3	1	14
Above 58y	F(11)	2	0	0	9
	M(33)	2	2	1	28

M=Male; F= Female

**Fig. 1:** The appearance of the anterior loop on a dental panoramic radiograph**Fig. 2:** Gender distribution of subjects according to age groups. The total number of subjects 480; male and female subjects were 257 and 223, respectively.

Discussion

The inferior alveolar nerve is a major sensory branch of mandibular division of trigeminal nerve. It runs through the mandibular canal and divides

into terminal branches in the premolar region as mental nerve and incisive nerve.

The mental nerve is the largest branch of inferior alveolar nerve. Usually three mental nerve branches emerge out of mental foramen [6]. It passes through the mental canal as an intraosseous anterior loop and emerges from the mental foramen to supply sensory innervations to skin of the lower lip, mucous membrane and gingiva of mental region. The incisive neurovascular bundle continues within the incisive canal to supply lower anterior teeth.

Anterior loop cannot be seen clinically but can be detected in radiographs such as dental panoramic radiographs, Computed Tomography, CBCT and MRI. Several studies on cadaveric mandible have shown that the prevalence of anterior loop is 61.5 - 96% with symmetric occurrence in 76.2% [1]. Radiographic studies by Yosue and Brooks⁵ revealed presence of anterior loop in 21% of 297 radiographs. While Jacobs et al [8] noticed 11% of anterior loop visible in panoramic radiographs but only 3% were well visualized. Similarly, about 12% was reported in a study by Arzouman et al as viewed on dental panoramic radiograph [3].

Various studies have shown wide variation in anterior loop length [9]. Due to variation in length, a fixed distance mesially from mental foramen cannot be assumed even with current recommendation of a safety margin of 4-6mm [10]. No consistent results on visualization of anterior loop on panoramic radiographs are found. Study done by Iyengar et al showed a visibility of anterior loop on at least one side in only 21% of total radiograph examined [4]. In a study by Neha Singh et al, only 10% cases showed presence of anterior loop [4]. The visibility of the anterior loop was noted in 49% males and 51% in female subjects. Studies by Kuzmanovic et al (27%) [11], Yosue and Brooke (21%) [5], Jacob et al (11%) [8] and Arzouman et al (

12%) [3] reported variation in incidence of visibility of anterior loop in panoramic radiographs. Failure to view anterior loop does not definitively mean it is absent and it may be due to limitation in the ability to visualize the anterior loop. We performed our study using panoramic radiograph as it is the most routinely used imaging technique.

Many reasons attribute to under examination of anterior loop on plain films. Poor radiographic bone quality, distorted images or obscured images [12], inability to distinguish anterior loop from trabecular pattern because anterior loop is an intramedullary structure that is located in an area with thick cortical plates [3]. Studies have shown that the identification of anterior loop reduced with increased age of the subjects. Results were similar to our study. This could be attributed to reduced calcification of cortex and enlarged marrow spaces and disordered trabeculae [13]. Percentage of absence of anterior loop in older subjects was high due to quantitative and qualitative changes in bone [7]. We selected dentate subjects for our study as alveolar bone undergoes resorption as reported [14] following loss of teeth thus affecting visualization of the anterior loop of the mental canal. We used panoramic radiographs in our study as it is the most commonly used diagnostic tool in preoperative evaluation of implant site and not much study has been undertaken in Indian population. In a comparative study using panoramic radiographs and CBCT using human cadaver heads by Hu et al [15] concluded that the mandibular panoramic radiographs can be used safely. Different studies have shown that the panoramic radiographs are unreliable in assessing anterior loop due to inherent limitations of tomographic layer to capture the entire areas appropriately [4].

Ngeow et al [16] showed that the anterior loop was visible in 40.2% dental panoramic radiographs and was often observed bilaterally followed by right side only similar to our study. Arzouman et al identified anterior loop on panoramic radiographs in 56-76% using different panoramic machines [3].

Many authors have concluded that panoramic radiography is not sufficient for presurgical implant planning in the mental region and may need to be supplemented with other modalities such as CT, CBCT for better visualization of the area [2]. Dissimilar diagnostic technique may be the reason for diverse findings. In case the AL of the mental nerve cannot be determined definitely, a safe guideline of about 6 mm to the most anterior point of the mental foramen need to be considered to avoid any neurological complication.

References

1. Walton JN. Altered sensation associated with implants in the anterior mandible: a prospective study. *J Prosthet Dent.* 2000; 83(4):443-9.
2. Anatomy of mandibular vital structures. Part II: Mandibular incisive canal, mental foramen and associated neurovascular bundle in relation with dental implantology. *J Oral Maxillofac Res.* 2010; 1(1):e3, 1-10.
3. Arzouman MJ, Otis L, Kipnis V, Levine D. Observation of the anterior loop of the inferior alveolar canal. *Int J Oral maxillofac implants.* 1993; 8:295-300.
4. Neha Singh, Prashant P Jain, Sushma Jaju, Rohit Agarwal. Detection of anatomical variations in mandible by panoramic radiography. *Journal of cranio- maxillary diseases.* 2014; 3(2):95-100.
5. Yosue T, Brooks SL. The appearance of mental foramina on panoramic radiographs. I. Evaluation of patients. *Oral Surg Oral Med Oral Pathol.* 1989; 68: 360-364.
6. Mraiwa N, Jacobs R, Merman P, Lambrichts I, Van Steenberghe D, Quirynen M. Presence and course of the incisive canal in the human mandibular interforaminal region: two dimensional imaging versus anatomical observations. *Surg Radiol Anat.* 2003; 25(5-6):416-23.
7. Wei Cheong Ngeow, Dionetta D Dionysius, Hayati Ishak, Prabhakaran Nambiar. A radiographic study of the visualization of the anterior loop in dentate subjects of different age groups. *Journal of Oral Science.* 2009; 51(2):231-237.
8. Jacobs R, Mraiwa N, Van Steenberghe D, Sanderink G, Quirynen M. Appearance of the mandibular incisive canal on panoramic radiographs. *Surg Radiol Anat.* 2004; 26:329-333.
9. Lamia H Al-Nakib, Sarkawt Khidhir Rasul. Evaluation of the anterior loop of the mental nerve incidence and extension in different age groups in sulaimania city using digital imaging system. *J Bagh College Dentistry* 2013; 25(1):99-104.
10. Dusan V Kuzmanovic, Alan GT Payne, Jules A Kieser, George J Dias. Anterior loop of the mental nerve: a morphological and radiographic study. *Clin Oral Impl. Res.* 2003; 14:464-471.
11. Kuzmanovic DV, Payne AG, Kieser JA, Dias GJ. Anterior loop of the mental nerve: a morphological and radiographic study. *Clin oral implants Res.* 2003; 14:464-471.
12. Dharmar S. Locating the mandibular canal in panoramic radiographs. *Int J Oral Maxillofacial Implants.* 1997; 12:113-117.
13. Kingsmill VJ, Boyde A. Variation in the apparent dentistry of human mandibular bone age and dental status. *J Anat.* 1998; 192(2):233-244.

14. Kieser J, Kuzmanovic D, Payne A, Dennison J, Herbison P. Patterns of emergence of the human mental nerve. *Arch Oral Biol.* 2002; 47:743-747.
 15. Hu KS, Choi DY, Lee Wj, Kim HJ, Jung Uw, Kim S. Reliability of two different presurgical preparation methods for implant dentistry based on panoramic radiography and cone beam computed tomography in cadavers. *J Periodontal Implant Sci.* 2012; 42: 39-44.
 16. Ngeow WC, Dionysius DD, Ishak H, Nambiar P. A radiographic study on the visualization of the anterior loop in dentate subjects of different age groups. *Oral Sci.* 2009; 51(2):231-7.
-