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Research Article

Prevalence of Anterior Loop Assessment by Digital Panoramic Radiography

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Abstract

Anterior loop is defined as mental neurovascular bundle which crosses anterior to the mental foramen and then doubles back to exit the mental foramen and it is important to determine the placement of implants in the mandibular premolar region. This study was taken to assess the prevalence of anterior loop and emergence pattern by digital panoramic radiographs.

Materials and Methods: A total of random sample of 368 panoramic radiographs of subjects selected randomly coming for dental treatment with advised OPG of 3 different age groups were taken with using machine specifications. Intra examiner reliability was assessed by kappa-statistics and percentages of observations were obtained to find out association of age and gender.

Results: This study includes 197 males (53.5%) and 171 females(46.5%) of age group of 20yrs to above 60 years of age. 20.9% of the subjects shown bilateral loop prevalence followed by right side(15.2%) and the most commonly observed pattern was the straight pattern of the total radiographs.

Conclusion: Anterior loop was visible in 77 (20.9%) dental panoramic radiographs bilaterally, (15.2%) right side only. Panoramic radiography is not sufficient for pre surgical implant planning in the mental region and may need to be supplemented with other modalities such as CT and CBCT for better visualization of the area.

Keywords: Mental Nerve (MN); Mental Foramen (MF)

Introduction

Dental practitioners face some problems during dental treatments because of anatomic landmarks in the field of treatment and are forced to change their treatment plan. Hence it is essential to know well-defined anatomic landmarks in order to avoid potential complications of dental treatment. If the treatment procedure is related to lower jaw, as a track followed by course of the inferior alveolar nerve, location or anatomic variations of mandibular foramen, mandibular canal and mental foramen is needed to avoid complications [1].

Dental implant and chin osteotomy are procedures executed on the mandible body frequently. The inferior alveolar neurovascular bundle passes through the mandibular canal, finally divides into two parts (the mental and incisive branches), and participates in the formation of the anterior loop [2]. The mental nerve (MN) is a general somatic afferent nerve that provides sensation to the lip, chin, and gingival tissue. It is the terminal branch of the mandibular nerve, which is the third division of the trigeminal nerve. MN exits the mandible through the mental foramen, divides into 3 branches deep to the depressor anguli oris muscle, and supplies the skin and mucous membrane of the lower lip, the skin of the chin, and the vestibular gingiva of the mandibular incisor [3].

A complication such as neurosensory alterations in the chin and lower lip can occur if important vital structures such as mental foramen (MF) and anterior mental loop are not properly identified and protected. MF has many anatomical variations not only in its size and shape but also its location and direction of the opening [4].

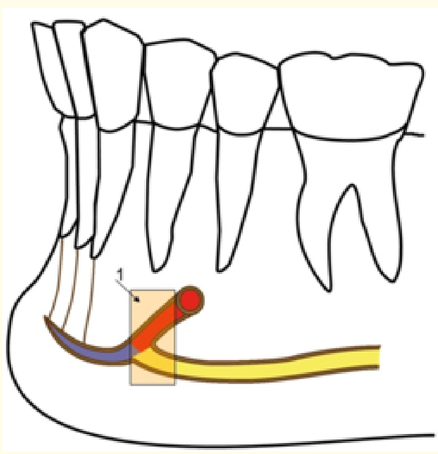

Figure a: The anterior loop (AL) of the Mental nerve: length variations from the most anterior loop point to mental foramen. Colours: blue = MIC, red = mental canal (the anterior opening of the mandibular canal). yellow = mandibular canal. 1 = length of the AL (0.00 to 10 mm). Credits:- Juodzbalys G, Wang HL, Sabalys G.

Among researchers of the incidence and extent of the anterior loop of the mental neurovascular bundle. Anterior looping cannot be appreciated clinically but can be visualized in about 11-60% of panoramic radiographs [5]. While intraoral (periapical) radiographs have not been recommended for preoperative assessment of the extent of the anterior loop, there have been some attempts by researchers to correlate visualization of these radiographs with anatomic reality (Bavitz., *et al*. 1993; Mardinger., *et al*. 2000).

Morphometric studies have either broadly divided the pattern into loop type and nonloop types, [6] or have described various patterns such as a posteriorly directed, an anteriorly directed (Figure 2 and a right angled pattern of emergence (Figure 3)) [7].

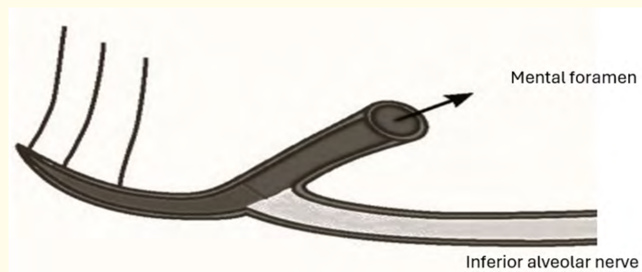

Figure 1: Anterior loop.

Credits:- Mr. Divakar Thiruvenkata Krishnan.

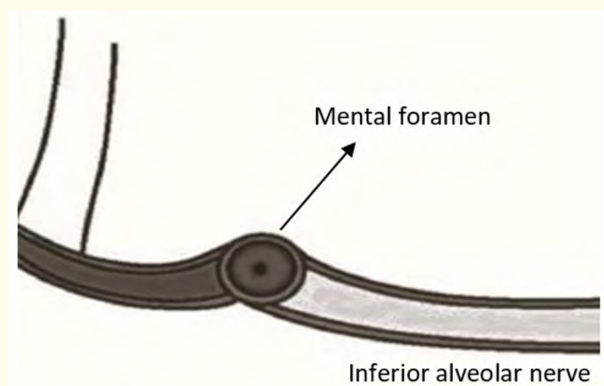

Figure 2: Straight pattern.

Credits:- Mr. Divakar Thiruvenkata Krishnan.

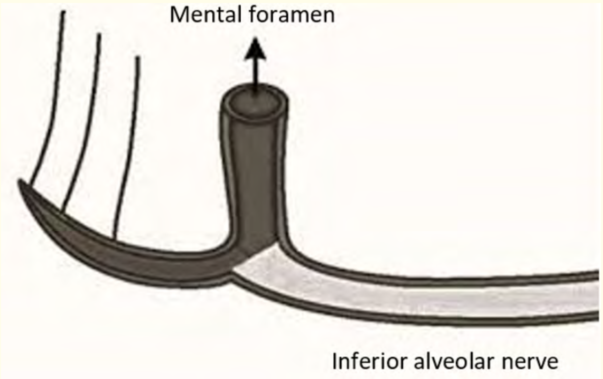

Figure 3: Perpendicular pattern.
Credits:- Mr. Divakar Thiruvenkata Krishnan.

Solar., *et al*. was used to classify the directional paths. According to this classification Type 1 is described as absence of anterior loop, the anatomy is Y-shaped with the incisive branch usually as wide as the main branch. The mental branch leaves the inferior alveolar nerve posterior to the opening of the mental foramen. Type 2 is described as the absence of anterior loop, the anatomy is T-shaped with the incisive branch usually perpendicular to the main branch. The mental branch diverges from the inferior alveolar nerve perpendicular to the opening of the mental foramen. Type 3 is described as the presence of the anterior loop, the anatomy is Y-shaped with the incisive branch usually as narrow as the main branch [1]. With this back ground this study was undertaken to assess the prevalence of anterior loop and emergence pattern by digital panoramic radiographs and to assess the influence of age and gender n visualization of loop.

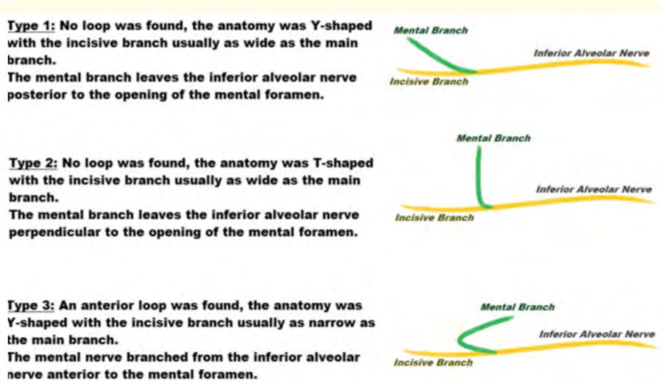

Figure b: Directional paths of mental foramen as proposed by Demir AM., *et al*.

Materials and Methods

This was a cross-sectional observational study conducted on patients who reported for dental treatment and were advised orthopantomographs (OPGs). A total of 368 digital panoramic radiographs were randomly selected from the records of the Department of Oral Medicine and Radiology, St. Joseph's Dental College.

Sample size estimation

Sample size was calculated to estimate the prevalence of the anterior loop (AL) on digital panoramic radiographs using the single-proportion formula:

$$n = Z^2 \times p(1 - p) / d^2$$

Where Z = 1.96 for 95% confidence, p = 0.30 (anticipated prevalence from previous literature), and d = 0.05 (absolute precision). The required sample size was n = 323. Allowing for 10% unusable or poor-quality radiographs, the final target sample size was set at n = 360 radiographs.

For the secondary objective of comparing prevalence between males and females, a two-proportion comparison with $\alpha = 0.05$ and 80% power was considered. To detect a 15% absolute difference (e.g., 35% vs. 20%), 138 subjects per group (total 276) were required; accounting for 10% exclusions, this yielded a target of ~306 radiographs. Thus, the chosen sample size of 368 radiographs provided adequate power both for prevalence estimation and for detecting sex-based differences of clinical relevance.

Study population and grouping

The radiographs included subjects aged 20 years and above, divided into three age groups: 20–40 years, 40–60 years, and above 60 years. Of the 368 radiographs, 197 were of males (53.5%) and 171 of females (46.5%).

Inclusion criteria

- Subjects aged 20 years and above.
- Radiographs of good quality with teeth present between the lower right and lower left second molars.
- Patients willing to participate and provide informed consent.

Exclusion criteria

- Deep caries, root canal treatment, or large restorations in the lower teeth.
- Pathologies in the lower arch or evidence of jaw fracture.

- Presence of supernumerary or unerupted teeth.
- Poor-quality or distorted radiographs.

Radiographic procedure

All panoramic radiographs were obtained using the Sirona Orthophos XG panoramic system, following standardized exposure parameters and patient positioning protocols.

Assessment and data collection

Each radiograph was examined to identify the mental foramen, presence or absence of the anterior loop, and the emergence pattern of the mental nerve (straight, perpendicular, or loop type) on both right and left sides. Observations were recorded systematically and tabulated.

Reliability and calibration

Intra-observer reliability was assessed using 50 randomly selected radiographs. Agreement was tested using Cohen's kappa statistics, and substantial agreement was achieved ($k < 0.8$).

Ethical considerations

Written informed consent was obtained from all participants before inclusion. The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki.

Results

A total of 368 panoramic radiographs of subjects were selected for the study in the age group of 20yrs to above 60 years of age. This study includes 197 males (53.5%) and 171 females(46.5%). Greater visibility of anterior loop was appreciated in subjects age ranging from 20- 40 years (74.2%). The visibility of anterior loops reduced as the age of the subjects increased. Only one anterior loop visible on left in older individuals. (as shown in figure 4). Males show greater visibility of anterior loop when compared to females. In the present study 20.9% of the subjects shown bilateral loop prevalence followed by right side (15.2%). Among all the patterns the most commonly observed pattern of entry of mental nerve was the straight pattern accounting for on at least one side, followed by the presence of an anterior loop and a perpendicular pattern on at least one side of the total radiographs examined (as shown in table 1). The agreement between the recordings made by observers one and two on either sides with respect to the presence of anterior loop, straight, and perpendicular patterns was found to be substantial significance of using Kappa test, $k < 0.8$.

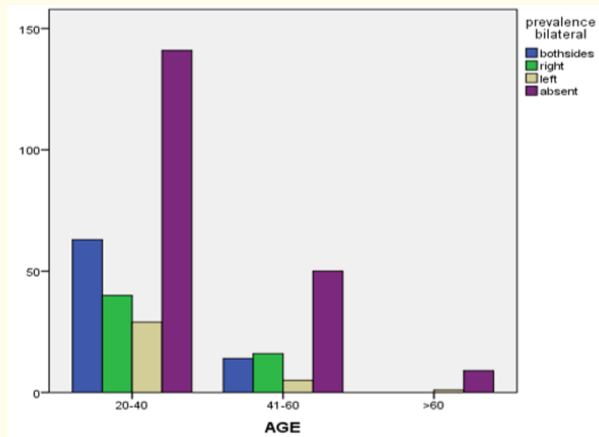

Figure 4: Visibility of anterior loop according to age.

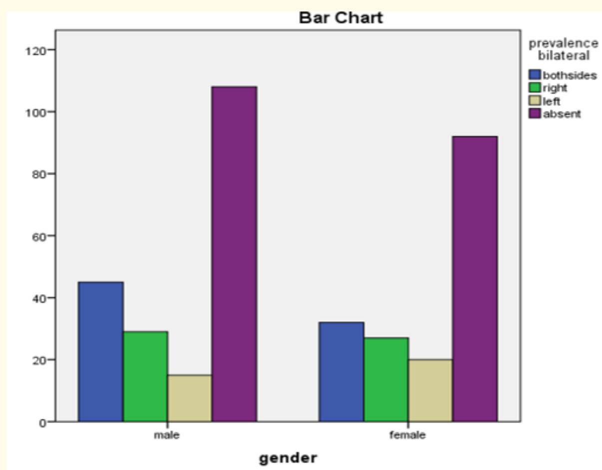

Figure 5: Visibility of anterior loop according to gender.

Prevalence of anterior loop	Frequency	Percentage	Right emergence pattern	Frequency	Percentage	Left emergence Pattern	Frequency	Percentage
Both sides	77	20.9%	Anterior loop	132	35.9%	Anterior loop	121	32.9
Right	56	15.2%	Straight	172	46.7%	Straight	196	53.3
Left	35	9.5%	Perpendicular	19	5.2%	Perpendicu-lar	16	4.3
Absence	200	54.3%	Absence	45	12.2%	Absence	35	9.5
Total	368	100%	Total	368	100%	Total	368	100%

Table 1: Frequency distribution of both sides of anterior loop and patterns of mental nerve.

Discussion

Radiographs have been the dominant source for diagnostic information on the maxillo-facial complex. Panoramic imaging modality is as the most routinely used tool in implant treatment planning because the advantages of panoramic imaging are the visualization of many anatomic features, low cost, and availability. Hu., *et al.* conducted a study on cadaveric mandibles to determine the intraosseous course of mental nerve, the transitional part between inferior alveolar nerve and mental nerve was classified based on its exit morphology into the loop, straight, and vertical patterns. The straight pattern was observed as a slight curve of mental canal opening directly into the mental foramen. The vertical pattern was seen when the mental canal bent perpendicularly into the foramen [7]. Though these patterns have been described in cadaveric studies, very few radiographic studies have been done so far to determine if such different patterns are visible as such on the radiographs as well. Based on these cadaveric findings, this study was undertaken to determine these three patterns on panoramic radiographs which are routinely used for the purpose of any preoperative surgical planning. The loop was present in 20.9% of all (368) subjects. In this present study higher visibility seen in 20-40 years of age group subjects and visibility decreased in older age group but when compared to the results of Wei Cheong Ngeow., *et al.* younger age group subjects shown low visibility of anterior loop, even their study stated that no association could be made between visibility of the anterior loop and gender. But the present study stated that males exhibit greater visibility of loop when compared to females (in figure 2). Visibility of anterior loops reduced as the age of subjects increased. In older subjects there may be a reduced calcification of the cortex that happens with age. Bone undergoes various quantitative and qualitative changes, but its remodelling appears to be slower with aging. After the age of 50, there is a marked increase in cortical porosity and the percentage of Haversian canals showing resorption [8]. As a result of this resorption, the marrow space enlarges and disordered trabeculae are often seen, affecting the identification of the anterior loop [9]. The results of the present radiographic study were much since the percentages of anterior loop (20.9%) observed were much less and that of the straight pattern was much higher than the cadaveric study. The percentage of perpendicular or right angle or vertical pattern observed was also lesser than that observed in the cadaveric study. The variability in the radiographic assessment of anterior loop may be explained by accounting for the different criteria used to define the anterior loop, dissimilar diagnostic techniques, and equipment and poor radiographic quality [10]. The underestimation of the anterior loop is because it is an inter medullary structure that is located in an area with relatively thick cortical plates, hence making it difficult to distinguish in plain films. The difficulty in identifying the mental foramen and anterior loop has been attributed to poor radiographs or bone quality, and the inability to distinguish these structures from the trabecular pattern [11]. Patient position and technician errors affect the quality of the radiograph. Objects that are outside the section or plane of focus (in the focal trough) will result in distorted or obscured images [12]. This study, while unable to confirm the presence of the anterior loop in elderly subjects, cannot definitively show that these subjects do not have anterior loops. Only a superior imaging modality such as CT may be able to improve on the findings of this study. Panoramic radiographs give only a 2-dimensional view of the area examined, there are advantages of using CT and CBCT in identifying the mandibular canal and anterior loop of mental nerve, although contradictory results have also been found [13,14].

Conclusion

Anterior loop was visible in 77 (20.9%) dental panoramic radiographs bilaterally, (15.2%) right side only. Males shows greater loop prevalence when compared to females. Even though Panoramic radiography is not sufficient for pre surgical implant planning in the mental region but panoramic imaging may be useful for visualization of many anatomic features, low cost and availability. For better visualization of the area we may need to be supplemented with other modalities such as CT and CBCT.

Future Directions

Although panoramic radiography is widely available and cost-effective, its limitations in detecting the anterior loop of the mental nerve highlight the need for further studies using advanced imaging modalities. Future research should incorporate Cone Beam Computed Tomography (CBCT) or conventional CT for more accurate three-dimensional visualization of the mandibular canal and anterior loop. Age-related changes in bone density and cortical resorption warrant longitudinal studies across different populations to better understand variations in anterior loop visibility. Multi-center studies with larger and more diverse sample sizes are recommended to improve the generalizability of prevalence data. Additionally, standardization of diagnostic criteria and radiographic interpretation protocols would help reduce variability and enhance reproducibility across studies.

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