ISSN: 2581-5989
PubMed - National Library of Medicine - ID: 101738774

International Journal of Dental Science and Innovative Research (IJDSIR)

IJDSIR : Dental Publication Service

Available Online at:www.ijdsir.com

Volume – 7, Issue – 4, August – 2024, Page No. : 120 - 127

Assessment of Anterior Loop Using CBCT Among South Indian Population: A Retrospective Cross-Sectional Study

[1]Dr. Joanna Gracy P, Post Graduate Student, Department of Prosthodontics and Crown & Bridge, Sri Venkateswara Dental College and Hospital, Chennai, India

[2]Dr. P.B. Yogesh, MDS, Professor, Department of Prosthodontics and Crown & Bridge, Sri Venkateswara Dental College and Hospital, Chennai, India

[3]Dr. Gajapathi Balaraman, MDS, Professor, Department of Prosthodontics and Crown & Bridge, Sri Venkateswara Dental College and Hospital, Chennai, India

[4]Dr. Rahmath Shameem Shafiullah, MDS, Associate Professor, Department of Prosthodontics and Crown & Bridge, Sri Venkateswara Dental College and Hospital, Chennai, India

[5]Dr. Arjun Badimela, MDS, Reader, Department of Prosthodontics and Crown & Bridge, Sri Venkateswara Dental College and Hospital, Chennai, India

[6]Dr. S. Chandrakala, MDS, Senior Lecturer, Department of Prosthodontics and Crown & Bridge, Sri Venkateswara Dental College and Hospital, Chennai, India

Corresponding Author: Dr. Joanna Gracy P, Post Graduate Student, Department of Prosthodontics and Crown & Bridge, Sri Venkateswara Dental College and Hospital, Chennai, India

Citation of this Article: Dr. Joanna Gracy P, Dr. P.B. Yogesh, Dr. Gajapathi Balaraman, Dr. Rahmath Shameem Shafiullah, Dr. Arjun Badimela, Dr. S. Chandrakala, "Assessment of Anterior Loop Using CBCT Among South Indian Population: A Retrospective Cross-Sectional Study", IJDSIR- August – 2024, Volume –7, Issue - 4, P. No. 120 – 127.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Aim: The aim is to evaluate the prevalence and quantify the ability of cone beam computed tomography (CBCT) to measure the length of the anterior loop. The anterior loop of inferior alveolar nerve (IAN) should be considered during the planning of placement of dental implants to avert injuries.

Materials and methods: A total of 139 cone beam computed tomography scans were obtained and assessed in the IAN was traced along with the anterior loop and its length was measured.

Results: The prevalence of anterior loop was 64% which is about 70.79% and 29.21% in male and female participants respectively. The anterior loop had a mean length of 3.44 ±0.78 mm in males and 2.44 ±0.98 mm in females.

Conclusion: CBCT provides an accurate means to identify critical anatomical features in the interforaminal

region during surgical planning of dental implants to avert injury to the anterior loop of IAN.

Keywords: Anatomical variation, Anterior loop, Cone beam computed tomography, Interforaminal region.

Introduction

Treatment of edentulous mandible with an implant-supported fixed prosthesis commonly supported by 3 to 6 implants placed in the interforaminal space with distal extension has a high success rate.[1] The inferior alveolar nerve (IAN), a branch of the mandibular division of the fifth cranial nerve, the trigeminal nerve, is an important structure that innervates the lower face and the mandible, including the teeth, the temporomandibular joint, and the mucous membrane of the mouth and the anterior two-thirds of the tongue, the masticatory muscles, and some smaller muscles. The IAN maintains an intraosseous course within the mandibular canal and terminates as the mental nerve through the mental foramen located between the roots of mandibular premolars.

The anterior interforaminal region, often considered the safest zone for implant placement, has three important anatomical structures namely the incisive canal, the mental foramen, and the anterior loop of the inferior alveolar nerve.[2] The position of the posterior implants is crucial because it determines the length of the extension of the distal prosthesis and the number of biomechanically appropriate implants.[3] Hence, it is important to understand the course of the nerve and its ramifications to prevent inadvertent errors during implant procedures.

The anterior loop of IAN is an anatomical variation wherein the canal proceeds anteromedially creating a loop before exiting through the mental foramen. Jalbout and Tabourian described the anterior loop as “an extension of the inferior alveolar nerve, anterior to the mental foramen, before exiting the canal”. [4] This anatomic variation which is not seen clinically, is often discovered during radiographic investigations. Neurosensory disturbances of the chin and lower lip, either temporary or permanent are the most frequent accidental complications during implant placements due to failure to identify the anatomic variations. [5,6] Ellies and Hawker observed sensory disturbances in the first 2weeks of surgery in about 36 % of patients and 13 % of patients after one year. [7] Another study has reported that 8.5% of the patients reported altered sensation in the chin and the lower lip following implant placement. [8]

Although periapical and panoramic radiographic modalities are easy and widely available, they are not suitable for the identification of the anterior loop of the IAN because of distortion, magnification errors, and inability to reconstruct images in buccolingual dimension. [9] Cone-beam computed tomography (CBCT), the gold standard, providing multiplanar views of the facial skeleton with a reduced radiation dose, compared to the most commonly used Computed tomography (CT) has been employed to produce a highly detailed 3-dimensional image for precise presurgical assessment of the interforaminal region. [5,6,10]. Several studies [11] have demonstrated the highly variable prevalence and length of the anterior loop of IAN. Yet variations exist in the prevalence and length of the anterior loop between different populations and ethnic groups. [12] The purpose of this study was to assess the prevalence and quantify the ability of CBCT to measure the length of the anterior loop of the IAN among the South Indian population in order to provide data regarding the surgically safe zone in the anterior mandibular interforaminal region for successful implant-supported prosthetic rehabilitation.

Materials and methods

The study was approved by the Institution Ethics Committee (ID: IEC/SVDCH/2414). A total of 139 CBCT scans of the mandible requested for diagnostic

purposes such as implant placement, pre-orthodontic assessment, surgical extraction of impacted teeth, root fracture, or complex endodontic treatment were retrieved and collected from scan centres in Chennai.

Criteria for Selection

Inclusion Criteria

- Subjects with age ≥18 years old of both sexes; partial or full edentulous and dentate subjects.
- CBCT images with bilateral visualization of the mandible
- Subjects with no oral-maxillofacial surgical intervention manifested in the radiographs.
- Radiographic images that are free of artifacts and optimal bone density (enabling the detection of the mandibular canal and outlining its boundaries).

Exclusion Criteria

- CBCT scans with poor image quality either due to artifact (due to the presence of metal dental restorations) or patient movement or image not adequately revealing the area of interest.
- Presence of an extensive bony lesion/defect or fractures in the interforaminal region.
- Severe resorption of the alveolar ridge (alveolar ridge crest reaching the mandibular canal).
- Presence of implant in the mental area.

A total of 139 CBCT scans were selected and analyzed. All CBCT scan images were obtained using the Sirona Orthophos, GALILEOS version 1.7, (Sirona, Germany) with a flat panel detector with the following exposure parameters: 85 kVp, 10–42 mA, 14 s exposure time and 0.3 mm × 0.3 mm × 0.3 mm voxel size. All the images were examined twice by a single examiner on Ultraviewer 6.0 with high resolution (1920×1080) using Sirona Galileo's software.

The anatomy of the whole mandible was assessed in the axial, coronal cross-sectional, and panoramic views. The inferior alveolar nerve was traced by the nerve option in the software on both sides of each projection along with the anterior loop **(Figure 1)**. In the case of detection of the loop, a line (A) was drawn from the most anterior point of the loop margin perpendicular to the inferior border of the mandible, and another line (B) was drawn from the anterior border of the mental foramen perpendicular to the inferior border of the mandible **(Figure 2)**. The shortest linear distance between lines A and B was drawn and measured as the length of the anterior loop of the IAN.

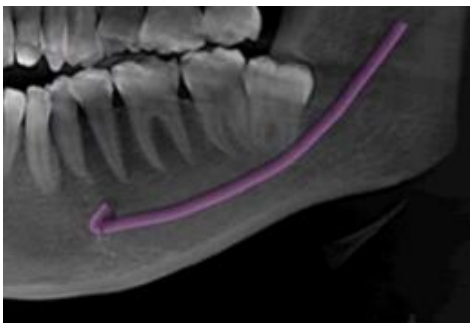

Figure 1: Tracing of the Inferior alveolar nerve along with the anterior loop.

Figure 2: Measurement of the length of anterior loop.

Line A - Most anterior point of the loop margin perpendicular to the inferior border of the mandible;

Line B - anterior border of the mental foramen perpendicular to the inferior border of the mandible.

Statistical analysis: The prevalence of the anterior loop was presented using percentage and the difference between males and females was assessed using Chi Square test. The length of the anterior loop was compared using independent t test. All the data were analyzed with

software (IBM SPSS Statistics v20.0; IBM Corp) at 0.05 level of significance.

Results

A total of 139 CBCT scans were evaluated; of which 94(68%) were male participants and 45(32%) were female participants. The anterior loop was present in 89 (64%) of the 139 participants and it was found to be 70.79% and 29.21% in males and females respectively. The results did not show significant differences in the presence of anterior loop between genders **Table 1** (P = 0.087).

The anterior loop was present bilaterally in 34 participants (38.2%). 55 out of the 89 participants had the presence of the anterior loop unilaterally accounting to 61.8% of the total. There was no significant differences in the bilateral or unilateral presence of anterior loop between genders **Table 1** (P = 0.12, Chi- square test). Overall length of the anterior loop ranged between 0.62 and 5.01mm, with a mean length of 3.44 ±0.78 mm in males and 2.44 ±0.98 mm in females. Males had a significantly longer length of the anterior loop than that of females **Table 2** (P = 0.001, t- test). The mean length of the anterior loop on the left and right sides were 3.25 ±1.02 mm and 3.09 ±0.87 mm respectively. There was no significant difference in the length of the anterior loop between the left and right sides **Table 3** (P = 0.539, t-test).

Table 1: Prevalence of anterior loop between genders

Prevalence of loop	**Males**		**Females**		**P value**
	N	%	N	%	
Present	63	67.02	26	57.78	0.087
Absent	31	32.98	19	42.22	
Bilateral	23	36.51	11	42.31	0.12
Unilateral	40	63.49	15	57.69	

Table 2: Length of anterior loop between genders

Group	**N**	**Mean length ± SD (mm*)**	**P value**
Male	40	3.44 ±0.78	0.001
Female	15	2.44 ±0.98	

* millimetre

Table 3: Comparison of length of loop (Right vs Left)

Group	**N**	**Mean length± SD (mm*)**	**P value**
Left	28	3.25 ±1.02	0.539
Right	27	3.09 ±0.87	

* millimetre

Discussion

The rehabilitation of the edentulous mandible presents difficulties because of several constraining factors. Treatment planning for dental implant placement in the anterior interforaminal region is often challenging because of the unknown extent of the anterior loop of the neurovascular bundle. The factors affecting the prosthetic design are the available vertical restorative space (AVRS), other anatomical variations such as arch form, arch size and also the interforaminal distance (IFD), affected by the mandibular nerve play a significant role in determining the size and position of implants in the mandibular anterior region. [13]

The mental foramen serves as a crucial reference point for the placement of interforaminal implants in an edentulous mandible. Understanding the significance of anatomical structures within the interforaminal region is essential to avoid errors during implant placement. Considerable variability in the path of the inferior alveolar nerve presents an additional challenge in predicting its course. Precise knowledge of the mental foramen and the possibility that an anterior loop may overreach mesially to the foramen are vital to ensure a safe distance, thus preventing any surgical complications due to potential

inaccuracies. The use of periapical mandibular premolar and panoramic radiographs has proved to be unreliable because of the potential for radiographic artefacts leading to false positives [14].

The anterior loop has been reported to be underestimated due to its location within an area surrounded by relatively thicker cortical walls, making it challenging to distinguish on conventional radiographs. [15] The limitations of panoramic radiographs in visualizing the anterior loop do not imply its significant absence. [16] Literature reports number of studies, where the authors using various methods, (anatomical, radiographical and combined), have attempted to measure the length of the anterior loop of the inferior alveolar nerve in various populations. [2,11,16,17] This study evaluates the prevalence and quantify the ability of cone beam computed tomography (CBCT) to measure the length of the anterior loop.

In this study, the prevalence of anterior loop of inferior alveolar nerve was found to be 64%. Similar findings were reported by Sitaraman, [18] Puri et al, [19] Rodricks et al[20] in varied parts of Indian populations. Panoramic radiographic visualization of the anterior loop has reported presence in 33.4% of population studied which is far lesser than the present CBCT study. [21] A comparable study conducted by Mathew [22] reported that more than half (52%) of the anterior loop was not detected in panoramic radiography and concluded that panoramic radiography led to false-positive diagnostics of the loop. In contrast, Sinha et al [23] and Giroh et al [24] found that the prevalence of anterior loop was only 9.7% and 6.9% respectively. The broad spectrum of variation can be ascribed to differences in the anatomy among individuals which is influenced by factors such as gender, age, race and variations in measurement techniques performed. Another significant factor to consider is corticalization, which affects the visibility of the canal. Enhanced corticalization may result in clearer visibility and improved canal visualization. [24] The prevalence of anterior loop in this study was observed unilaterally in 61.8% and it was in the left side in 31.5 % and right side in 30.3 % participants. The anterior loop was observed bilaterally in 38.2% of participants.

The planning and placement of the posterior implants in the edentulous mandibular fixed or removable rehabilitation is critical as it dictates both the length of the distal prosthesis extension and the optimal number of biomechanically suitable implants. [3] The length of the AL plays a significant role in the use of tilted implants. [24] The actual length of the anterior loop may assist in planning the implant placement in the vertical as well as the horizontal direction around the mental foramen. In a study involving individuals from the Indian population with edentulous mandible, the horizontal space available (38.9 mm interforaminal) was found to be less compared to that reported in Western population. While planning a bar and clip attachment for an overdenture, an interimplant distance of 6 mm is necessary for the clip accommodation. [13]

The mean length of the anterior loop in this study was found to be 3.44 mm and 2.44mm in males and females respectively with a significantly longer length in males. The physique associated with race could potentially be a significant factor influencing the length of the anterior loop.[24] Mathew reported the mean length to be 0.10 ± 0.13 mm on panoramic radiographic evaluation. [22] In literature, there has been a wide variation in the reported anterior loop length which varied from 0.30 mm - 19 mm in different populations. [11] Due to inconsistency and diverse variability in the anterior loop length it is unreliable to depend on any fixed values. Clinicians must consistently utilize available 3D imaging modalities in every case during the planning of dental implants near the

mental foramen region. This approach ensures accurate identification and measurement of the anterior loop length, thereby mitigating the risk of injury.

Taking into account the widely prevalent anterior loop which is an anatomical variation of inferior alveolar nerve and the inability of 2D imaging modalities in accurately depicting the anterior loop, it is crucial for professionals to identify and measure the anterior loop utilizing the method outlined in this study using a 3D CBCT during implant planning in the mandibular anterior region. The study's findings reveal a notable prevalence and considerable extent of the anterior loop of the inferior alveolar nerve which underscores the prior knowledge of this anatomical variation during the planning and placement of implants in the anterior interforamen region. Further research involving larger sample sizes, inclusion of different age groups and dentition status is necessary to fully assess the variability in the extension of the anterior loop of the inferior alveolar nerve using CBCT imaging.

Conclusion

Cone beam computed tomography (CBCT) scan is a necessity for each patient and also serve as a reliable tool to visualize a safety zone during the planning of implants in the anterior interforaminal region. Proper marking of the path of the inferior alveolar nerve is essential to avert injury to the anterior loop of inferior alveolar nerve.

References

1. Juan del VL, Grageda E, Gómez Crespo S. Anterior loop of the inferior alveolar nerve: Averages and prevalence based on CT scans. J Prosthet Dent. 2016 Feb;115(2):156-60.
2. Nikkerdar N, Golshah A, Mahmoodivesali R, Falah-Kooshki S. Assessment of Implant-Related Anatomical Landmarks in the Mandibular Interforaminal Region in an Iranian Population Using Cone-Beam Computed Tomography. Contemp Clin Dent. 2022 Apr-Jun;13(2):125-134.
3. Osier JF. Biomechanical load analysis of cantilevered implant systems. J Oral Implantol 1991;17:40-7.
4. Jalbout Z, Tabourian G, editors. Glossary of Implant Dentistry II. International Congress of Oral Implantologists, Upper Montclair, NJ; 2008.
5. Scarfe WC, Farman AG (2008) What is cone-beam CT and how does it work? Dent Clin North Am 52:707–730.
6. Scarfe WC, Farman AG, Sukovic P (2006) Clinical applications of cone-beam computed tomography in dental practice. J Can Dent Assoc 72:75–80.
7. Bartling R, Freeman K, Kraut RA. The incidence of altered sensation of the mental nerve after mandibular implant placement. Journal of Oral and Maxillofacial Surgery. 1999;57(12):1408-10
8. Panjnoush M, Rabiee ZS, Kheirandish Y. Assessment of location and anatomical characteristics of mental foramen, anterior loop and mandibular incisive canal using cone beam computed tomography. J Dent (Tehran) 2016;13:126-32.
9. K. Tsiklakis, C. Donta, S. Gavala, K. Karayianni, V. Kamenopoulou, and C. J. Hourdakis, “Dose reduction in maxillofacial imaging using low dose cone beam CT,” European Journal of Radiology, vol. 56, no. 3, pp. 413–417, 2005.
10. Mishra SK, Nahar R, Gaddale R, Chowdhary R. Identification of anterior loop in different populations to avoid nerve injury during surgical procedures-a systematic review and meta-analysis. Oral Maxillofac Surg. 2021 Jun;25(2):159-174.
11. do Nascimento EH, Dos Anjos Pontual ML, Dos Anjos Pontual A, da Cruz Perez DE, Figueiroa JN, Frazão MA, Ramos-Perez FM. Assessment of the anterior loop of the mandibular canal: A study using

cone-beam computed tomography. Imaging Sci Dent. 2016 Jun;46(2):69-75.

12. Bhargava A, Sehgal M, Gupta S, Mehra P. Classification system on the selection of number of implants and superstructure design on the basis available vertical restorative space and interforaminal distance for implant supported mandibular overdenture. J Indian Prosthodont Soc. 2016 Apr-Jun;16(2):131-135.
13. Gupta A, Pubreja L, Malik R, Gupta N. Evaluation of the Dimensions of Anterior Loop of Mental Nerve in CBCT: A Radiographic Analysis. J Maxillofac Oral Surg. 2020 Jun;19(2):168-172.
14. Wismeijer D, van Waas MAJ, Vermeeren JIJF, Kalk W. Patients' perception of sensory disturbances of the mental nerve before and after implant surgery: a prospective study of 110 patients. Br J Oral Maxillofac Surg. 1997;35:254–259.
15. 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. J Oral Sci. 2009;2:231–237.
16. Sun-Kyoung Yu, Seog Kim, Shin Gu Kang, Jae Hyuk Kim, Kyeong Ok Lim, Seong-Ik Hwang, Heung - Joong Kim. Morphological assessment of the anterior loop of the mandibular canal in Koreans. Anat Cell Biol 2015;48:75-78.
17. Sitaraman M. A. Prevalence and length of anterior loop of inferior alveolar nerve. Indian Journal of Public Health Research & Development. 2019;10 (11):3504–3508.
18. Puri A, Verma P, Mahajan P, Bansal A, Kohli S, Faraz SA. CBCT Evaluation of the Vital Mandibular Interforaminal Anatomical Structures. Ann Maxillofac Surg. 2020 Jan-Jun;10(1):149-157.
19. Rodricks D, Phulambrikar T, Singh SK, Gupta A. Evaluation of incidence of mental nerve loop in Central India population using cone beam computed tomography. Indian J Dent Res. 2018 Sep-Oct;29(5):627-633.
20. Arul kumar S, P. B. Yogesh, Ganesh Kumar R, Gajapathi B, Arjun B, Aishwarya Raju. A Radiographic Study on the Visualization of Anterior Loop in dentate subjects using Orthopantomograph - An Original Research. International Journal of Dental Science and Innovative Research 2021;4(6):49 – 55.
21. Mathew A, N M. Prevalence, length, and patterns of Anterior Loop among the South Indian population: A comparative study between Panoramic Radiography and Cone Beam Computed Tomography. Porto Biomed J. 2023 Jun 23;8(3):e216.
22. Sinha S, Kandula S, Sangamesh NC, Rout P, Mishra S, Bajoria AA. Assessment of the Anterior Loop of the Mandibular Canal Using Cone-Beam Computed Tomography in Eastern India: A Record-Based Study. J Int Soc Prev Community Dent. 2019 May-Jun;9(3):290-295.
23. Giroh VR, Hebbale M, Mhapuskar A, Modak R, Agarwal P. Prevalence of Anterior Loop and other Patterns of Mental Nerve in a Sample Population of an Indian City: A Retrospective Study. Ann Maxillofac Surg. 2022 Jan-Jun;12(1):11-16.