Mylohyoid Ridge an indicator of safety measure for injury against inferior alveolar nerve and lingual cortex in posterior mandibular implant placement – A Retrospective CBCT Study.

Shraddha Rasne[1], Dr. Lata Kale[1], Dr. Amruta Bansode[1], Dr. Vishwas Kadam[1], Preeti Baride[1], Nida Shaikh[1]
[1]Department of Oral Medicine And Radiology, CSMSS Dental College And Hospital Chhatrapati Sambhajinagar, Maharastra, India.

Corresponding Author:
Shraddha Rasne
Email ID :

OPEN ACCESS

Submission: 16.08.2023 Acceptance: 30.09.2023 Publication: 17.12.2023

Abstract:

Introduction: Implant placement in the posterior mandible is a complex procedure due to the proximity of vital neurovascular structures and the potential for lingual cortical perforation. Accurate preoperative assessment of the inferior alveolar nerve, submandibular fossa anatomy, and available bone volume is crucial for treatment planning and preventing complications. While the mylohyoid ridge has been traditionally used as a landmark for estimating bone height, its reliability is limited. Cone beam computed tomography (CBCT) imaging provides superior visualization of these anatomical structures, enabling precise implant planning and reducing the risk of postoperative complications.

Aims and objectives: The study aimed to accurately determine the position of the mandibular canal and submandibular fossa based on the mylohyoid ridge using CBCT scans. This would help to prevent damage to the nerves and blood vessels within the mandibular canal and avoid perforating the lingual cortex.

Materials and methods: Cone beam computed tomography scans of posterior mandible of 62 subjects were studied using Software NNT Viewer Version 13.0 and the distance between the highest point on mylohyoid ridge and upper margin of mandibular canal and the deepest point of submandibular fossa .

Results: - On an average the mandibular canal was 5.5 mm and 4 mm inferior to the mylohyoid ridge in the second and first molar region respectively. And the depth of the fossa undercut in vertical and horizontal dimension was higher in second molar region than in first molar region.

Conclusion: - This study gives the range of linear dimensions between the mandibular canal and mylohyoid ridge along with depth and distance of submandibular fossa undercut from mylohyoid ridge which in turn depicts the availability of bone for placement of implant safely.

Keywords: CBCT, Mylohyoid Ridge, Submandibular Fossa, Mandibular Canal, Lingual Cortex,

Introduction:

The use of dental implants is widely accepted as an option for prosthodontic reconstruction after tooth loss[(1)]. Since the introduction of dental implants and the groundbreaking concept of osseointegration, the field of implant dentistry has witnessed remarkable advancements. The placement of endosseous dental implants has become a very popular option for comprehensive oral rehabilitation in both partially and completely edentulous patients. With proper presurgical planning, most dental implant surgeries proceed uneventfully[(2)]. Critical factors in dental implant treatment planning involve a comprehensive assessment of bone architecture and the spatial relationship between the proposed implant and vital anatomical structures, including nerves and blood vessels. Two-dimensional intraoral and panoramic radiography have become ubiquitous in dental practice over the past decade. However, the inherent limitations of 2D imaging, such as the superimposition of complex osseous structures, often hinder accurate interpretation. Consequently, critical anatomical landmarks, including the neurovascular-rich lingual foramen and incisive canal, can be challenging to precisely locate. Advancements in dental imaging technology have significantly enhanced the clinician's ability to meticulously assess dental structures and formulate precise preoperative treatment plans. Compared to conventional two-dimensional techniques, CBCT imaging presents as main advantages the elimination of superimposition of neighbouring structures, and absence of image magnification[(3)]. The posterior mandible poses a significant implant surgical risk. In the absence of proper preoperative assessment of implant length and angulation, this region is susceptible to neurovascular injury and perforation of the lingual cortex[(4)]. The posterior mandible is a surgically challenging region due to the close proximity of vital structures, including the inferior alveolar nerve and the submandibular fossa. Implant placement in this area carries a heightened risk of neurovascular bundle injury and lingual cortical perforation, necessitating meticulous preoperative planning and execution. Iatrogenic injuries to inferior alveolar nerve (IAN) are a well-documented

complication of third molar surgeries, implant placement, osteotomies, or fracture repair. The considerable variation in the course, the shape, curve, and direction of the nerve as well as the terminal segment of IAN complicates the regional anatomy. Hence, it is often difficult to predict the exact position of the nerve, thus impeding a proper preoperative planning[5]. Inadvertent manipulation of the lingual cortex can cause arterial trauma, with subsequent hematoma formation in the sublingual and submandibular spaces. The mouth floor is vascularized by branches of the sublingual and submental arteries, and in patients with atrophic mandibles, potential injuries are located closer to the floor of the mouth[6]. Important determinants of implant placement in the posterior mandible are the submandibular fossa (SMF) and the mandibular canal (MC), which show variability that restricts ideal implant placement[4]. These are two limiting factors for determining the dental implant fixture length in mandibular posterior edentulous region: Inferior dental canal and submandibular fossa[7]. It is interesting to know that the IAN is the most commonly injured nerve (64.4%), followed by the lingual nerve (28.8%) (Tay & Zuniga 2007)[8]. Damage to submandibular gland fossa by lingual plate perforation during the surgery may lead to severe haemorrhage and subsequent hematoma which have life-threatening consequences due to upper airway obstruction[9]. The mylohyoid ridge (MR) is often overlooked as a guide for determining available bone height in the mandibular posterior region. The mylohyoid ridge is a prominent bony ridge on the inner surface of the mandible. It serves as the attachment site for the mylohyoid muscle, which plays a crucial role in mastication and swallowing. While its importance in prosthetic treatment is well-established, its potential as a reliable guide for assessing bone height in the posterior mandible is less frequently discussed. The internal MR onto which the mylohyoid muscle attaches and the SMF are inherently considered to be non-resorbable structures as they are integral parts of the basal bone of the mandible. Loss of premolars and molars has no effect on

MR position, but MR prominence increases with continuous resorption and period of edentulousness[4].

Materials and Methods :

Before starting the study, the Ethical clearance was approved from ethical committee of the college– CSMSS/DCH/EC/SS/2023-18. The study was retrospective observational type and was performed by examining the cone beam computed tomography (CBCT) scans of total 62 patients. CBCT data of these 62 patients was studied from the radiological archives of the diagnostic centre in Aurangabad, Maharashtra. The study did not expose any patients to CBCT radiation specifically for the purpose of this research. The anonymity of the patients and confidentiality of the data were ensured. All CBCTs were taken from the same machine; NEWTOM Go 3D CBCT Scanner machine the SOFTWARE NNT Viewer Version 13.0, by single trained personnel following manufacturer-recommended protocol and settings. The field of view was 10 x10 as this was the most readily available scan in the archive. CBCT datasets were studied and measurements were recorded according to the selected variables.

Inclusion criteria	Exclusion criteria
1) Patients from the age group of 20 to 60 years of age.	1) Patients with existing co-morbidities of bone.
2) CBCT scan image which showed mandibular posterior teeth.	

Methods of measurement :

Scan images of the mandibular posterior molar region were selected and marked with the reference points by using the tools SOFTWARE NNT Viewer Version 13.0

This was done to measure -

1) The linear distance between the mylohyoid ridge
2) The upper margin of mandibular canal
3) The depth of submandibular fossa by using the different angular parameters.

The reference points taken were –

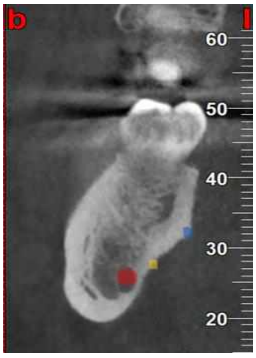


Figure no. 1

Blue mark – Highest Point On Mylohyoid Ridge
Yellow mark – Deepest Point Of Submandibular Fossa
Red mark – Upper Margin Of Mandibular Canal

figure 2

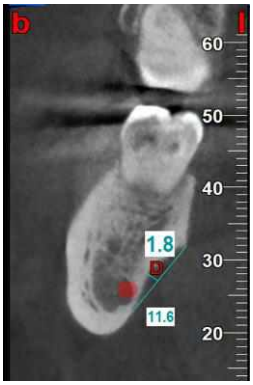


figure 3

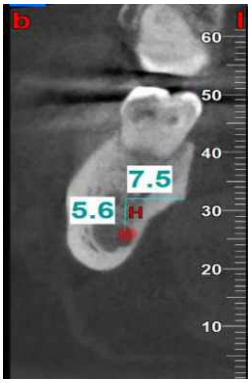


figure 4

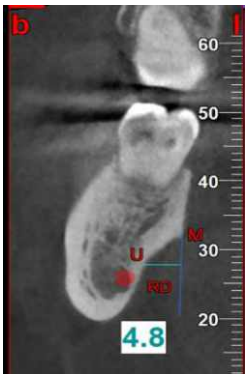


figure 5

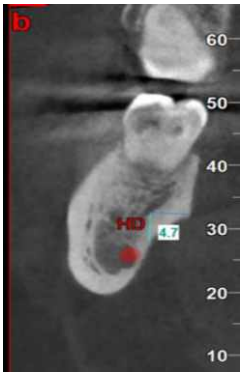


figure 6

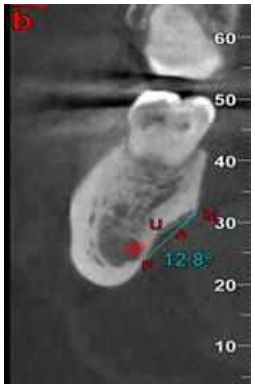
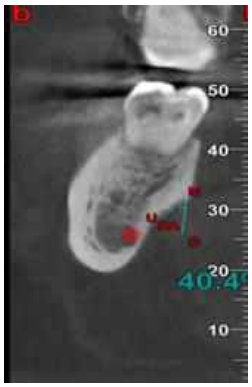


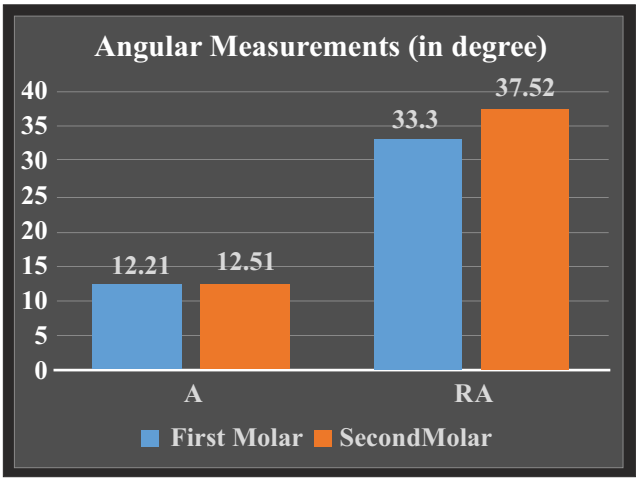
figure 7



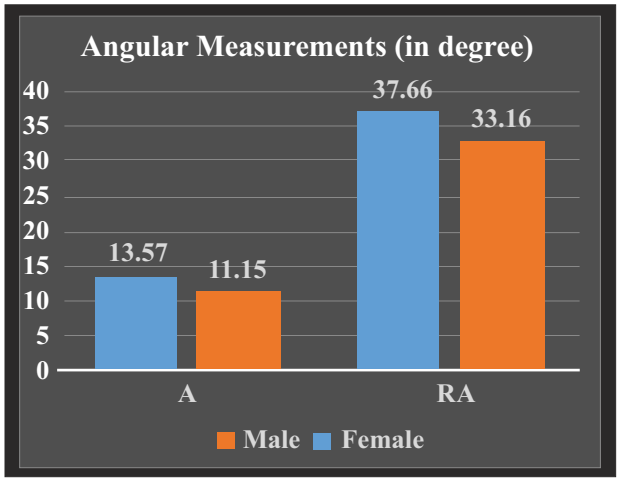
Results :

Statistical analysis was performed using Statistical Product and Service Solution (SPSS) version 21 for Windows (SPSSInc, Chicago, IL). Descriptive quantitative data was expressed in mean and standard deviation respectively. Descriptive qualitative data was expressed in percentage/proportion. Unpaired t test was used to find comparison between male and female in respect to mylohyoid anatomic landmark parameters. Pearson 'r' correlation coefficient test was used to find correlation between bone height with various mylohyoid anatomic landmarks to know the best predictor.

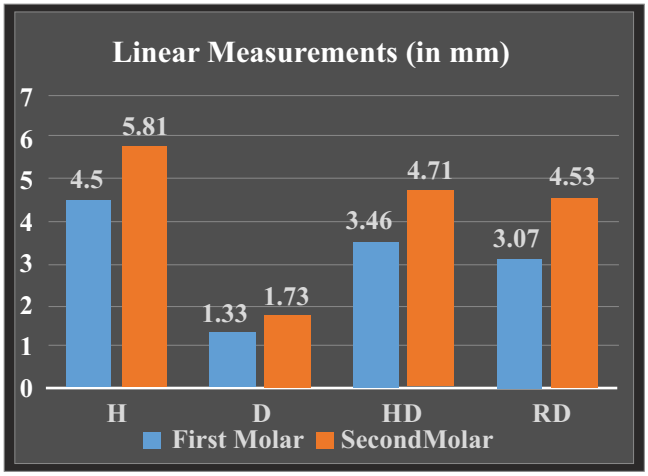
Graph 1



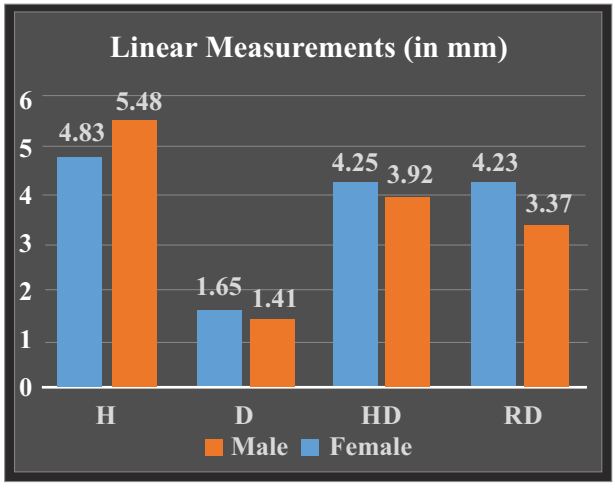
Graph 2



Graph 3



Graph 4



The linear measurements when compared in between first and second molars of right and left side (graph 1) gives the mean value of H is 4.5 and 5.81, D is 1.33 and 1.73, HD is 3.46 and 4.71 and RD is 3.07 and 4.53 respectively. This signifies that the values of "H" bone height, "HD" deepest point of the undercut or submandibular fossa, "D" depth of the undercut in the horizontal direction, "RD" relative depth of the undercut in horizontal direction, is more for the second molar and slightly less for the first molar which proves that the mandibular canal is more in proximity to the root apices of the first molar and the depth of the submandibular fossa is more at first molar region.

The angular measurements when compared in between first and second molars of right and left side (graph 2) gives the mean value of is angle A 12.21 degree and 12.51 degree, angle RA is 1.33 degree and 1.73 degree respectively. It shows comparison of angular measurements of angle A-angle related to the mylohyoid ridge , deepest point of submandibular fossa , and lower border of the submandibular fossa called as angle of undercut and angle RA which is the angle between the mylohyoid ridge, deepest point on submandibular fossa called relative angle of undercut is near about same value for first and second molar which signifies that the angle of implant placement should be nearly same at both molar sites with respect to deepest point and mylohyoid ridge.

Again the linear and angular measurements (graph 3 and graph 4) when compared in male and female groups respectively for same variables then the mean of linear measurements comes to H value 4.83 and 5.48, D value 1.65 and 1.41 , HD value 4.25 and 3.92, RD value 4.23 and 3.37 , angle A value 13.57 and 11.15 degrees , angle RA value 37.66 and 33.16 degrees respectively. This depicts that the mandibular canal is nearer to mylohyoid ridge in males than in females and the depth of submandibular fossa with respect to mylohyoid ridge is more in males as compared to females.

Discussion :

A thorough understanding of the specific locations of key anatomical points in the jaw, such as the mandibular foramen, submandibular fossa and mental foramen, and the pathway of the nerves and blood vessels, is vital for achieving positive outcomes in oral and maxillofacial surgeries. With the advent of newer modalities of imaging, the surgeon can visualize real-time images which hitherto was not possible. The precise knowledge of the location of the various mandibular anatomical landmark is highly valuable to overcome various surgical complications. Iatrogenic injuries to inferior alveolar nerve (IAN) are a well-documented complication of third molar surgeries, implant placement, osteotomies, or fracture repair. The considerable variation in the course, the shape, curve, and direction of the nerve as well as the terminal segment of IAN complicates the regional anatomy. Hence, it is often difficult to predict the exact position of the nerve, thus impeding a proper preoperative planning[5]. CBCT is a promising technique for the detailed evaluation of important bony structures, providing diagnostic images with good resolution while demanding relatively low radiation dose[3]. Our study sought to establish the co-relation between the mylohyoid ridge, mandibular canal and the submandibular fossa. This study examines the mylohyoid ridge as a traditional anatomical landmark that can assist surgeons in placing implants at an appropriate depth, avoiding the impingement of nerves and vessels in mandibular canal and ensuring proper angulation to prevent perforation of the lingual plate by taking into the account depth of submandibular fossa. The positions of the mandibular canal and the mylohyoid line are both influenced by the loss of teeth. The distance between the mylohyoid line and the alveolar crest decreases with tooth loss, especially in the M1 and M2 regions[11]. There are two limiting factors for determining the dental implant fixture length in mandibular posterior edentulous region. Inferior dental canal and submandibular fossa[7]. Our study gives a clear vision that

how CBCT is of crucial importance in examining and evaluating the measurements of available bone height and angulation of the implant placement.

In our study we considered 4 linear dimension variables and 2 angular variables with respect to mylohyoid ridge, mandibular canal and submandibular fossa. There variables were studied at mandibular first and second molars bilaterally. Variables were –

1. Bone height (H)
2. Depth of the undercut in horizontal direction (D)
3. Relative depth of undercut in horizontal direction (RD)
4. Deepest point of undercut (HD)
5. Angle of undercut (Angle A)
6. Relative angle of undercut (Angle RA)

Hence after considering all the comparative values in our results we come to an conclusion that keeping placing the implant 2mm below the mylohyoid ridge can be considered as margin of safety.

Conclusion:

This study offers a comprehensive analysis of the linear and angular measurements of the mandibular canal and submandibular fossa in relation to the mylohyoid ridge. These measurements are crucial for determining the appropriate bone height and implant angle for safe placement. Consequently, the mylohyoid ridge serves as a valuable anatomical reference point for guided implant surgery.

Funding – None

Conflict of interest – None declared

References :

1. Hans-Joachim Nickenig, Manfred Wichmann, Stephan Eitner, Joachim E. Zöller, Matthias Kreppel, Lingual concavities in the mandible: A morphological study using cross-sectional analysis determined by CBCT, Journal of Cranio-Maxillofacial Surgery, Volume 43, Issue 2, 2015, Pages 254-259, ISSN 1010-5182
2. Leong, Daylene Jack-Min BDS*; Chan, Hsun-Liang DDS*; Yeh, Chu-Yuan DDS, MS*; Takarakis, Nikolaos DDS*; Fu, Jia-Hui BDS*; Wang, Hom-Lay DDS, MSD, PhD†. Risk of Lingual Plate Perforation During Implant Placement in the Posterior Mandible: A Human Cadaver Study. Implant Dentistry 20(5):p 360-363, October 2011. | DOI: 10.1097/ID.0b013e3182263555
3. Oliveira-Santos C, Capelozza AL, Dezzoti MS, Fischer CM, Poleti ML, Rubira-Bullen IR. Visibility of the mandibular canal on CBCT cross-sectional images. J Appl Oral Sci. 2011 May-Jun;19(3):240-3. doi: 10.1590/s1678-77572011000300011. PMID: 21625740; PMCID: PMC4234336.
4. Madhok S, Kiruthika S, Prabhu K, Abraham S, Kabilan P, Nithyapriya S. Mylohyoid Ridge as a Predictor of Available Bone for Implant Placement: A Cone-Beam Computed Tomography (CBCT) Retrospective Observational Study. Cureus. 2022 Jul 29;14(7):e27470. doi: 10.7759/cureus.27470. PMID: 36060375; PMCID: PMC9421098.
5. Balaji SM, Krishnaswamy NR, Kumar SM, Rooban T. Inferior alveolar nerve canal position among South Indians: A cone beam computed tomographic pilot study. Ann 1-5. doi: 10.4103/2231-0746.95319. PMID: 23483095; PMCID: PMC3591087.
6. Lílian Azevedo de Souza, Neuza Maria Souza Picorelli Assis, Rosangela Almeida Ribeiro, Antônio Carlos Pires Carvalho, Karina Lopes Devito, Assessment of mandibular posterior regional landmarks using cone-beam computed tomography in dental implant surgery, Annals of Anatomy - Anatomischer Anzeiger, Volume 205, 2016, Pages 53-59, ISSN 0940-9602,
7. Rahpeyma A, Khajehahmadi S. Submandibular fossa augmentation in implant dentistry. J Indian Soc Periodontol. 2017 May-Jun;21(3):207-209. doi: 10.4103/jisp.jisp_392_16. PMID: 29440787; PMCID: PMC5803876.
9. Juodzbalys G, Wang HL, Sabalys G, Sidlauskas A, Galindo-Moreno P. Inferior alveolar nerve injury associated with implant surgery. Clin Oral Implants Res. 2013 Feb;24(2):183-90. doi: 10.1111/j.1600-0501.2011.02314.x. Epub 2011 Nov 1. PMID: 22092662.
10. Ramaswamy, P.; Saikiran, Ch.; Raju, B. Mrudula; Swathi, Myla; Teja, Davuluri Divya. Evaluation of the depth of submandibular gland fossa and its correlation with mandibular canal in vertical and horizontal locations using CBCT. Journal of Indian Academy of Oral Medicine and Radiology 32(1):p 22-26, Jan–Mar 2020. | DOI: 10.4103/jiaomr.jiaomr_170_19
11. Kumar D, Brar R, Ahmad T, Narad C, Sodhi SPS, Kaur A. Assessment of the anterior and caudal extent of inferior alveolar nerve canal, location of inferior alveolar canal and mental foramen, and the depth of submandibular fossa using computed tomography. Natl J Maxillofac Surg. 2021 Sep-Dec;12(3):380-386. doi: 10.4103/njms.NJMS_186_20. Epub 2021 Dec 13. PMID: 35153435; PMCID: PMC8820312.
12 Aoki C, Nara T, Kageyama I. Relative position of the mylohyoid line on dentulous and edentulous mandibles. Okajimas Folia Anat Jpn. 2011 Feb;87(4):171-6. doi: 10.2535/ofaj.87.171. PMID: 21516982.