MORPHOLOGY OF ANTERIOR AND POSTERIOR MANDIBULAR RIDGES AND THE PREVELENCE OF LINGUAL CONCAVITY IN THE UNITED STATES DENTAL POPULATION

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by
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ABSTRACT

Introduction: Dental implant placement has become an increasingly popular method of tooth replacement. CBCT imaging has revolutionized dental implant planning by providing a three-dimensional view of intra-oral dental structures. The lingual concavity is a concave area located on the lingual surface of the posterior mandible. Perforation of the lingual concavity is associated with floor of the mouth bleeding and upper airway obstruction. A thorough understanding of the mandibular ridge morphology is critical to avoid surgical complications associated with lingual cortex perforations.

The objective of this study was to assess the morphology of the anterior and posterior mandibular lingual ridges, determine the prevalence of the posterior lingual concavity, measure the average length and depth of the concavity, and investigate the influence of gender, ethnicity, smoking status, and history of periodontal disease on mandibular ridge morphology.

Materials and Methods: The study was a retrospective analysis initially involving 1006 CBCT scans obtained from Temple University – Kornberg School of Dentistry from January 2020 to July 2022. Inclusion criteria included subjects who were above the age of 18. Exclusion criteria included subjects who were under the age of 18, subjects who received limited field of view CBCTs, and scans that were unintelligible due to scatter. 552 CBCT scans met the inclusion criteria and were included in the final analysis. Data was recorded on anterior and posterior mandibular lingual ridge shape, location, length, and depth.

Results: The mean age of subjects at the time of CBCT scan acquisition was 55 years. The study included 310 females and 242 males. 545 subjects (99%) presented with a convex mandibular anterior lingual ridge morphology. The average length in millimeters of the anterior lingual convexity was 19.01mm. There was a significant relation between anterior ridge length and smoking status (ANOVA, $F=4.819$, $p=0.016$). There was also a significant mean difference in anterior ridge length based on the history of periodontal disease (t-test, $t=8.683$, $p<2.2e-16$). The most prominent location of the mandibular lingual anterior convexity was at the central incisor site in 514 subjects. 332 subjects presented with a lingual concavity in the right posterior mandible (60.1%). 330 subjects presented with a lingual concavity in the left posterior mandible (59.8%). The average length in millimeters of the lingual concavity was 12.73mm and 12.35mm for the right and left posterior mandible. The average depth in millimeters of the lingual concavity was 2.03mm and 1.96mm for the right and left posterior mandible respectively. The most common location of the posterior mandible lingual concavity was found at the right first molar site in 184 subjects (52%) followed by right second molar in 165 subjects (46%) and the right second premolar in 6 subjects (2%).

Conclusion: CBCT imaging can improve the ability of practitioners to identify the mandibular lingual concavity and pre-plan dental implants of adequate dimensions. This may prevent complications associated with lingual concavity perforations, including potentially life-threatening hemorrhages and airway obstruction. Further research should incorporate a broader range of confounding variables (systemic conditions, medication usage), to better understand their impact on mandibular lingual ridge morphology.

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CHAPTER 1

INTRODUCTION

Cone-beam computed tomography (CBCT) has transformed dental imaging by providing a three-dimensional view of intra-oral dental structures. Visualization of these anatomic structures is critical for accurate diagnosis and treatment planning. CBCT technology provides detailed images of the teeth, alveolar bone and soft tissue making it an essential tool in dental surgical applications. Its most valuable application is in its use on cases include implant planning, orthodontic evaluations, maxillo-facial pathology detection, and analysis of complex dental anatomy. The high-resolution images obtained from CBCT scans allow for precise and accurate measurements of anatomic structures, facilitating more predicable treatment outcomes.

CBCT consists of a series of two-dimensional radiographs which are merged to form a three-dimensional representation of a patient's jaws. The concept was first introduced in the clinical setting for oral and maxillofacial surgery by Arai et al. in 1999 and Mozzeo et al. in 1998. Its success in their initial application has allowed clinicians to utilize CBCT imagine across various disciplines including dental implantology, orthodontics, endodontics, periodontics, and forensic dentistry. To date, the most widely used applications for CBCT imaging involve dental implant planning, and pre-operative assessments for surgical wisdom teeth extractions.

The American Academy of Oral and Maxillofacial Radiology (AAOMR) has recognized the importance of CBCT usage in dental practice settings and recommends its application for a variety of surgical treatment planning purposes. In the realm of implant dentistry, the AAOMR recommends CBCT imaging for assessing bone volume at implant sites, evaluating the success of bone grafts, analyzing the temporomandibular joint, and diagnosing pathologies. The use of CBCT in these scenarios significantly minimize surgical complications and enhancing the precision of treatment interventions (American Academy of Oral and Maxillofacial Radiology, 2013).

Prior to implant planning, one anatomic feature of the posterior mandible to consider is the lingual concavity or undercut. This is a concave area located on the lingual surface of the posterior mandible. It is speculated that variations of this undercut are related to the size and growth of structures located within the submandibular space. Perforation of the lingual cortex can result in life-threatening hemorrhage and infection (Chan et al., 2011).

Key anatomic structures that are located near the lingual concavity are the lingual artery and vein, lingual nerve, sublingual gland, submandibular gland and mylohyoid muscle. The lingual artery is a branch of the external carotid artery and supplies the floor of the mouth, tongue, and structures of the anterior portion of the neck. The lingual nerve provides sensory innervation to the anterior two-thirds of the tongue and floor of the mouth. The submandibular and sublingual glands are major salivary glands that are located beneath the mucous membranes of the floor of the mouth. The mylohyoid muscle is involved in elevating the floor of the mouth and assisting in both speech and swallowing.

The anterior mandibular lingual cortex is also surrounded by vital anatomic structures that require avoidance during implant osteotomy preparation: the sublingual artery and genioglossus muscle. The sublingual artery is a branch of the lingual artery and supplies blood to the floor of the mouth and the sublingual gland. This artery runs along the anterior mandibular cortex. The genioglossus muscle is responsible for tongue movement, airway maintenance and speech.

There are previous studies that have attempted to document and classify posterior mandibular lingual ridges. Chan et al in 2011 classified posterior mandibular morphology as being either C-type, P-type, or U-type. The U-type mandibular ridges are concave in nature. Rajput et al in 2018 classified lingual concavities based on depth. Type I ridges were less than 2 millimeters, Type II ridges were 2-3millimeters, and Type III were greater than 3mm in depth.

Several authors have also attempted to determine the prevalence of posterior mandibular lingual concavities. Nikenig et al in 2014 evaluated 716 cross sectional CBCTs of edentulous patients and found lingual concavity present in 68% of patients. Kamburoglu et al in 2015 found that the presence of right and left submandibular fossa was 77% and 72% respectively in both dentate and edentulous patients. Chan et al in 2011 found that 66% of 103 patients presented with a type U-ridge corresponding with a lingual undercut. Finally, Rajput et al in 2018 found 62% of 140 patients present with a Type II (2-3mm in depth) lingual concavity.

The depth of mandibular lingual concavities is variable across the literature depending on how it is measured. Chan et al in 2011 measured from most prominent coronal aspect of bone to the base of the ridge. The depth was then calculated by measuring from the initial line to the depth at the level 2mm above the inferior alveolar canal. They found the average depth to be 2.4mm in 103 subjects. Rajput et al in 2018 measured by drawing a line joining the most prominent superior and inferior points on the lingual concavity. The depth was then recorded as the deepest part of the concavity from the line.

When planning dental implants in the posterior mandible, there are numerous surgical complications associated with lingual cortical perforations that a clinician must recognize. These perforations can cause an apical fenestration of the implant which could result in inadequate osseointegration, peri-implantitis, soft tissue irritation, and alveolar bone loss (Durrani, 2013). Lingual concavity perforations can also result in damage of the lingual artery and vein. This could potentially produce a life-threatening hemorrhage and obstruct the upper airway. It can also lead to the formation of a hematoma in the floor of the mouth and can spread to loose tissues in the sublingual area and space between lingual muscles (Niamtu, 2001). Chan et al in 2011 reported that the incidence of lingual plate perforation can reach as high as 1-2%, however the real risk is much higher. Although lingual artery perforation is a rare complication, its occurrence can lead to irreversible damage (Kalpidis, 2004).

Practitioners should be prepared to manage hemorrhaging associated with lingual and sublingual artery perforations. Upper airway management is critical in these patients. Typically, direct visualization of the bleed is difficult due to the location of the vessels. If the bleeding is unable to be controlled using bimanual pressure, the focus should be diverted to a surgical approach. Surgical ligation under intubation or tracheostomy is the most widely used protocol for controlling floor of the mouth bleeding (Hwang et al., 2013).

Previous studies have attempted to document hemorrhages associated with lingual arterial perforations. Law et al in 2017 found that 17 of 21 (84%) of floor of the mouth hemorrhages were directly related to lingual cortex perforations. In some cases, bleeding is immediate, other reports show that bleeding may not be evident for up to 7 hours post-operatively. Exact incidence rates of sublingual and lingual artery perforations are not published in the literature – only described as case reports (Kyriaki et al., 2022) (Peñarrocha-Diago et al., 2019).

Given the complications of lingual cortical perforations, proper planning of implant surgeries in the posterior mandible is critical. Lingual bone concavities are not able to be visualized on two dimensional panoramic or peri-apical films. Therefore, it is pertinent to obtain a CBCT scan and pre-plan the prosthetically driven implant placement to allow for a 2mm facial and lingual plate, and a 2mm distance from the inferior alveolar nerve. In cases with insufficient bone volume, the surgeon should consider bone augmentation prior to implant placement (Patel et al., 2009).

The objective of this study was to assess the morphology of the anterior and posterior mandibular lingual ridges, determine the prevalence of the posterior lingual concavity, measure the average length and depth of the concavity, and investigate the influence of gender, ethnicity, smoking status, and history of periodontal disease on mandibular ridge morphology.

CHAPTER 2

MATERIALS AND METHODS

The study was a retrospective analysis initially involving 1006 CBCT scans obtained from Temple University – Kornberg School of Dentistry from January 2020 to July 2022. The study received Temple University – Office of Human Subjects Protection Institutional Review Board approval (protocol number 3032). A report was generated screening for all patients who received either a full mouth CBCT scan (D0365) or a mandibular CBCT scan (D0367) from the patient electronic health record system (Axium) used at the dental school. Inclusion criteria included subjects who were above the age of 18. Exclusion criteria included subjects who were under the age of 18, subjects who received limited field of view CBCT scans, and scans that were unintelligible due to scatter. 552 CBCT scans met the inclusion criteria and were included in the final analysis.

All CBCT scans were obtained using a Planmeca Viso G7 or ProMax 3D Mid (PLANMECA USA INC., Charlotte, NC, USA) machine with flat panel image detector. The devices were calibrated to the following settings: 0.3mm size Voxels produced at 100kV and 63mAs per image. 327 slices per scan were made with an exposure time of 24.4 seconds. The scans were then divided and analyzed by four calibrated periodontal residents and periodically checked by a calibrated licensed periodontist. Xelis CBCT viewing software was used to render and analyze the scans. The software provided a panoramic reconstruction viewing module, an MPR screen module that consisted of axial, sagittal, and coronal slices.

The collected data was recorded and compiled in a Microsoft Excel data table. The following information was documented from each subject (as described in Tables 1, 2 and 3):

- Age
- Gender (male or female)
- Ethnicity (African American, Caucasian, Asian, Hispanic)

- Smoking status (yes, no, former)
- History of periodontal disease (yes, no)
- Right dentition status (complete dentition, complete edentulous, partial edentulous)
- Left dentition status (complete dentition, complete edentulous, partial edentulous)
- Anterior ridge shape (parallel, convex)
- Anterior convexity location (central incisor, lateral incisor, canine)
- Anterior convexity length (mm)
- Anterior convexity depth (mm)
- Right posterior lingual ridge shape (concave, convex, parallel)
- Right posterior lingual ridge location (second premolar, first molar, second molar)
- Right posterior lingual ridge length (mm)
- Right posterior lingual ridge depth (mm)
- Left posterior lingual ridge shape (concave, convex. parallel)
- Left posterior lingual ridge location (second premolar, first molar, second molar)
- Left posterior lingual ridge length (mm)
- Left posterior lingual ridge depth (mm)

Table 1. Collection of right and left mandibular dentition status

Right Dentition Status (Full dentition vs Partial vs Edentulo	Left Dentition Status (Full dentition vs
Partial Edentulous	Complete Dentition
Partial Edentulous	Partial Edentulous
Partial Edentulous	Complete Dentition
Partial Edentulous	Partial Edentulous
Complete Dentition	Partial Edentulous
Complete Dentition	Partial Edentulous
Complete Edentulous	Complete Edentulous
Partial Edentulous	Partial Edentulous
Partial Edentulous	Partial Edentulous
Partial Edentulous	Partial Edentulous
Partial Edentulous	Partial Edentulous
Complete Dentition	Complete Dentition
Partial Edentulous	Partial Edentulous
Partial Edentulous	Partial Edentulous
Partial Edentulous	Partial Edentulous
Partial Edentulous	Partial Edentulous
Partial Edentulous	Partial Edentulous
Partial Edentulous	Partial Edentulous
Partial Edentulous	Partial Edentulous
Partial Edentulous	Partial Edentulous
Partial Edentulous	Complete Dentition
Partial Edentulous	Partial Edentulous

Table 2. Collection of primary variables associated with anterior and posterior mandibular lingual ridge morphology

Right Posterior Ridge Shape (parallel, convex, con	Right Posterior Lingual Ridge Shape Location	Right Posterior Lingual Ridge Shape Length	Right Posterior Lingual Ridge Shape Depth	Left Posterior Ridge Shape (parallel, conve:	Left Posterior Lingual Ridge Shape	Left Posterior Lingual Ridge Shape	Left Posterior Lingual Ridge Shape Depth
Concave	M2	9.7	-1.5	Concave	M2	12.7	-2.1
Concave	M1	10	-1.5	Concave	M1	10.2	-1.8
Concave	M1	9.6	-1	Concave	M1	8.4	-1.1
Concave	M1	7.2	-0.4	Concave	M1	7.4	-0.4
Concave	M1	14.5	-1.5	Concave	M1	14.3	-1.3
Concave	M1	13.3	-1.5	Concave	M1	16.8	-1.4
Concave	M1	9.9	-2.1	Concave	M1	8.7	-1.9
Concave	M1	13.3	-1.8	Concave	M1	12.1	-1.4

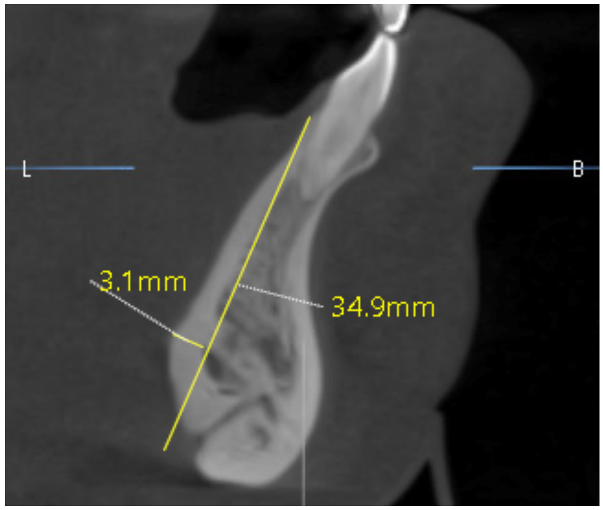
Table 3. Description of secondary variables recorded

Gender	Pt Age	Race/Ethnicity	Smoking	Hx Perio Dz
M	56	Caucasian	No	Yes
F	40	Asian	No	No
F	40	Hispanic	No	No
F	69	Caucasian	No	No
F	34	Caucasian	No	No
M	64	Caucasian	No	Yes
M	57	African American	Former	Yes
F	41	African American	Yes	No
F	66	African American	No	No
F	63	Caucasian	No	No
F	57	African American	Former	No
M	35	Caucasian	Yes	Yes
F	50	Hispanic	No	No
F	51	Caucasian	Yes	Yes
F	52	Caucasian	No	Yes
F	68	African American	Yes	Yes
F	64	African American	No	No
M	78	Caucasian	No	No
M	52	Caucasian	No	No
M	70	African American	Former	No
F	53	African American	No	No
M	64	Asian	No	No
F	55	Hispanic	Former	No
F	63	African American	No	Yes
F	67	Asian	No	No
F	29	Hispanic	Yes	No
F	74	Caucasian	No	No
M	76	Caucasian	No	No
F	53	Caucasian	No	No
F	77	Caucasian	No	No
M	55	Caucasian	No	No
F	48	Caucasian	No	No
M	65	Hispanic	Former	No
F	68	African American	No	No
F	50	African American	No	No
F	61	Caucasian	Yes	No
M	62	Caucasian	Yes	No
F	44	Caucasian	No	No
F	64	Hispanic	Yes	Yes
M	29	Caucasian	Former	No
M	64	Caucasian	No	No

Measurements for convex anterior mandibular lingual ridges were taken from the highest point at the top of the lingual cortex to the lowest point at the bottom of the lingual cortex to determine length (Figure 1). The depth was measured from a line connecting these two points to the most prominent part of the convexity. The depth measurements were recorded as a positive number in millimeters indicating a convexity (Figure 1).

Parallel anterior mandibular lingual ridges did not exhibit any concavities or convexities. Their depth measurements were recorded as 0mm.

Figure 1. Illustrating length and depth measurements (in millimeters) for the anterior lingual convexity



Concave and convex posterior mandibular lingual ridge measurements were taken from the most prominent point at the top of the lingual cortex to the most prominent point at the bottom of the lingual cortex to determine the length (Figures 2 and 3). Depth was measured from a line connecting these two points to the deepest point of the concavity or convexity (Figures 2 and 3). Concave ridges received negative depth measurements and convex ridges received positive depth measurements.

Figure 2. Illustrating length and depth measurements (in millimeters) for the posterior lingual concavity

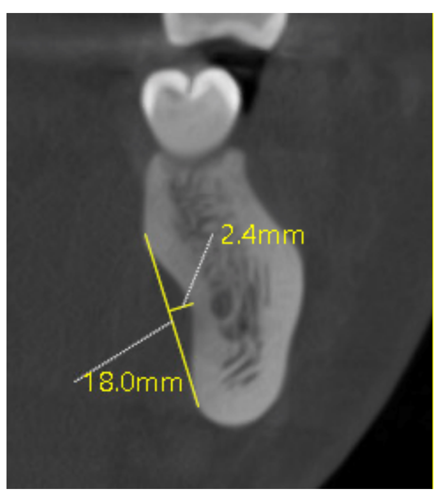
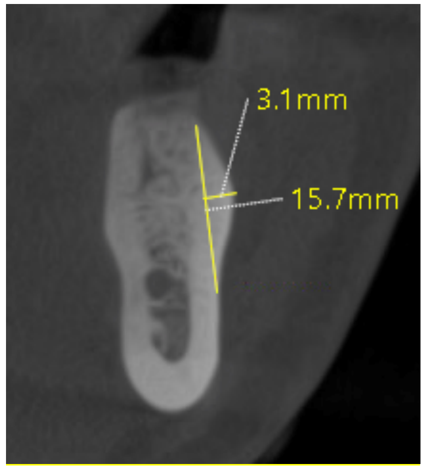
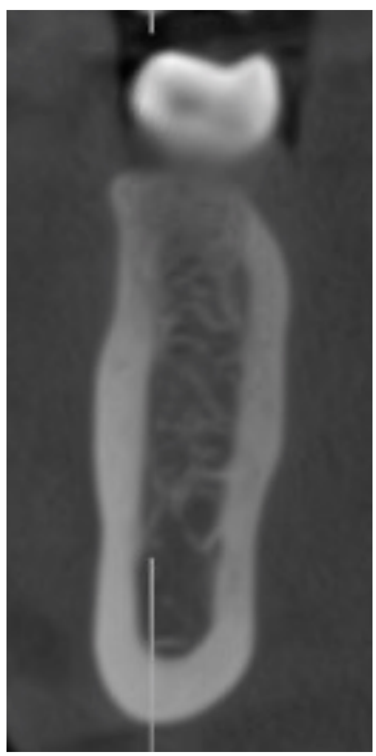


Figure 3. Illustrating length and depth measurements (in millimeters) for the posterior lingual convexity



Parallel posterior mandibular lingual ridges did not exhibit any concavities or convexities. Their depth measurements were recorded as 0mm (Figure 4).

Figure 4. Depicting a parallel posterior mandibular lingual ridge shape



Detailed statistical analysis was run in The R Project for Statistical computing. Descriptive statistics were used to calculate the prevalence of posterior mandibular lingual concavities. Statistical analysis was conducted to reveal morphologic variations in mandibular anterior lingual anatomy.

A bivariate analysis was run to determine possible associations between, anterior ridge shape, anterior convexity location, anterior ridge length, anterior convexity depth, right and left posterior ridge shape, posterior concavity and convexity location, posterior ridge length, and posterior concavity and convexity depth versus gender, age, race, smoking status, and history of periodontal disease.

Additional bivariate analysis was conducted to determine associations between, right/left posterior ridge length and right/left posterior concavity and convexity depth.

Multivariable regression analysis was conducted to evaluate associations between anterior ridge shape, convexity location ridge length, and convexity depth with age, gender, race, smoking status, and history of periodontal disease.

Multivariable regression analysis was conducted to evaluate associations between right and left posterior ridge shape, concavity/convexity location, length, and depth with age, gender, race, smoking status, history of periodontal disease, and dentition status.

CHAPTER 3

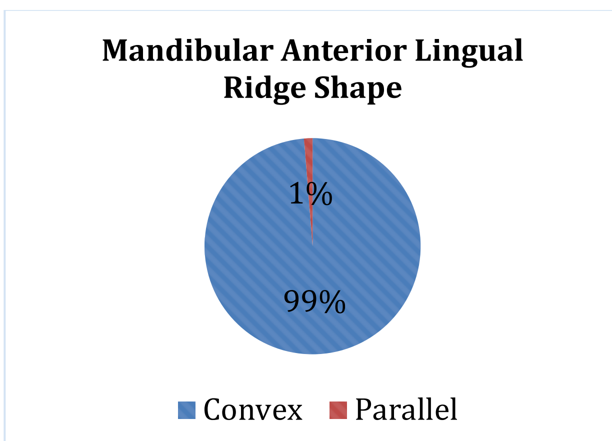
RESULTS

The mean age of subjects at the time of CBCT scan acquisition was 55 years. The study included 310 females and 242 males. There were 171 African American, 49 Asian, 264 Caucasian, and 88 Hispanic subjects included in the analysis. Of the total subjects, 78 presented with a complete right dentition, 31 presented with right complete edentulism, and 443 presented with right partial edentulism. Furthermore, 71 subjects presented with a complete left dentition, 20 subjects presented with left complete edentulism, and 451 subjects presented with left partial edentulism.

Anterior Mandible

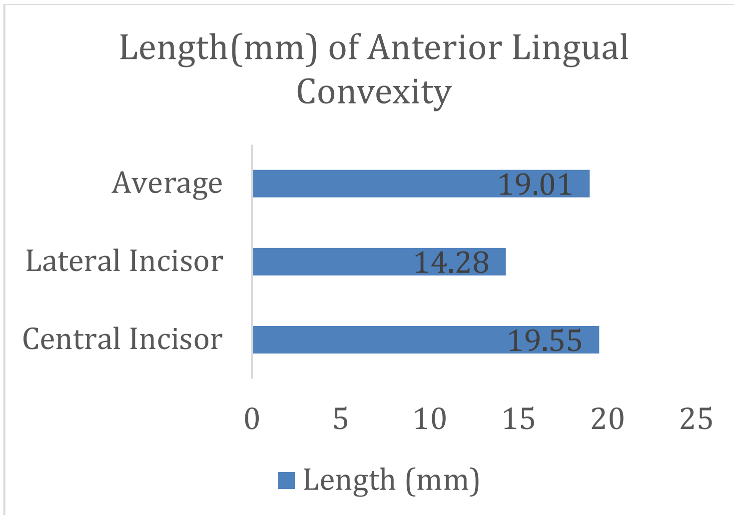
Of the 552 reviewed CBCT scans, 545 subjects (99%) presented with a convex mandibular anterior lingual ridge morphology. Only 7 subjects presented with a parallel ridge (Figure 5) . There was no significant relation between anterior ridge shape and age (t-test, t=1.095, p=0.314), gender (Chi-squared=0.509, p=0.475), and racial groups (Chi-squared=2.571, p=0.463).

Figure 5. Mandibular anterior lingual ridge shape prevalence



The average length in millimeters of the anterior lingual convexity was 19.01mm. The average length of the convexity was 19.55mm at the central incisor location and 14.28mm at the lateral incisor location (Figure 6).

Figure 6. Average length in millimeters of anterior lingual convexity by location



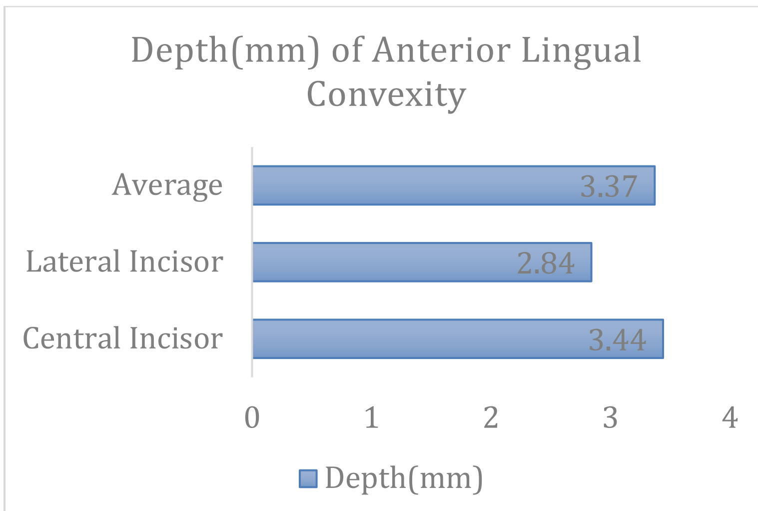
Bivariate analysis revealed that there was a significant relation between anterior ridge length and smoking status (ANOVA, F=4.819, p=0.016). There was also a significant mean difference in anterior ridge length based on the history of periodontal disease (t-test, t=8.683, p<2.2e-16).

Linear Regression analysis revealed that among smokers, there was a 3.478mm significant decrease in the anterior ridge length keeping age, gender, race, and history of periodontal disease diagnosis constant (p=0.002). Among individuals who had a history of periodontal disease diagnosis, there was also a 4.174mm significant decrease in the anterior ridge length keeping age, gender, race, and smoking status constant (p<2e-16). Both findings suggest that smoking and history of periodontal disease are associated with a reduction in anterior lingual ridge length.

The average depth in millimeters of the mandibular anterior lingual convexity was 3.37mm. The average depth at the location of the central and lateral incisor was 3.44mm and

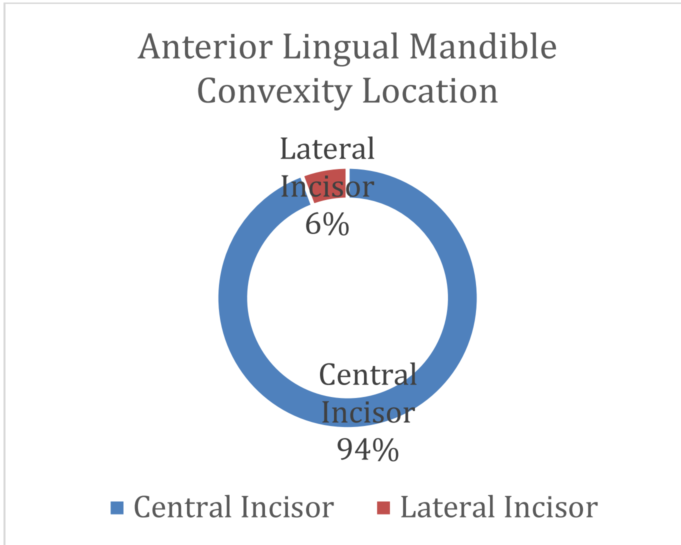
2.84mm respectively (Figure 7). Bivariate analysis revealed that there was a significant mean difference in anterior ridge depth based on the history of periodontal disease (t=3.12, p=0.002). Linear regression analysis found that among individuals who had a history of periodontal disease diagnosis, there was a 0.299-mm significant decrease in the anterior ridge length keeping age, gender, race, and smoking constant (p=0.003). This suggests that a history of periodontal disease is associated with changes in the morphology of the anterior mandibular ridge, specifically in terms of both depth and length.

Figure 7. Average depth in millimeters of anterior lingual convexity by location



The most prominent location of the mandibular lingual anterior convexity was at the central incisor site in 514 subjects, followed by the lateral incisor site in 31 subjects (Figure 8). There was no significant relation between anterior convexity location and gender groups (Chi-squared=0.807, p=0.668), age (F=0.661, p=0.517), racial groups (Chi-squared = 6.977, p=0.323), and smoking status (chi-squared=6.415, p=0.170).

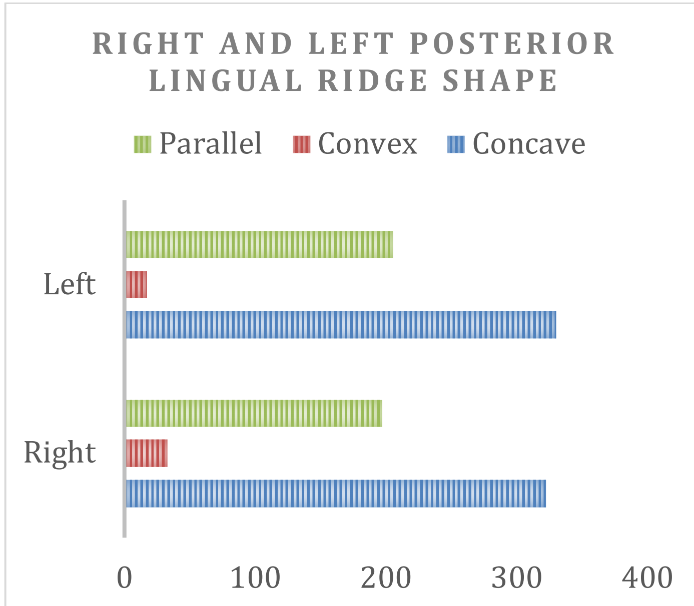
Figure 8. Location of anterior lingual mandibular convexity



Posterior Mandible

Of 552 reviewed CBCT scans, 332 presented with a lingual concavity in the right posterior mandible (60.1%). 197 subjects presented with a parallel right posterior lingual ridge and 33 subjects presented with a convex right posterior lingual ridge. 330 subjects presented with a lingual concavity in the left posterior mandible (59.8%). 205 subjects presented with a parallel left posterior lingual ridge and 17 subjects presented with a convex left posterior lingual ridge (Figure 9)

Figure 9. Right and left posterior lingual mandibular ridge shape

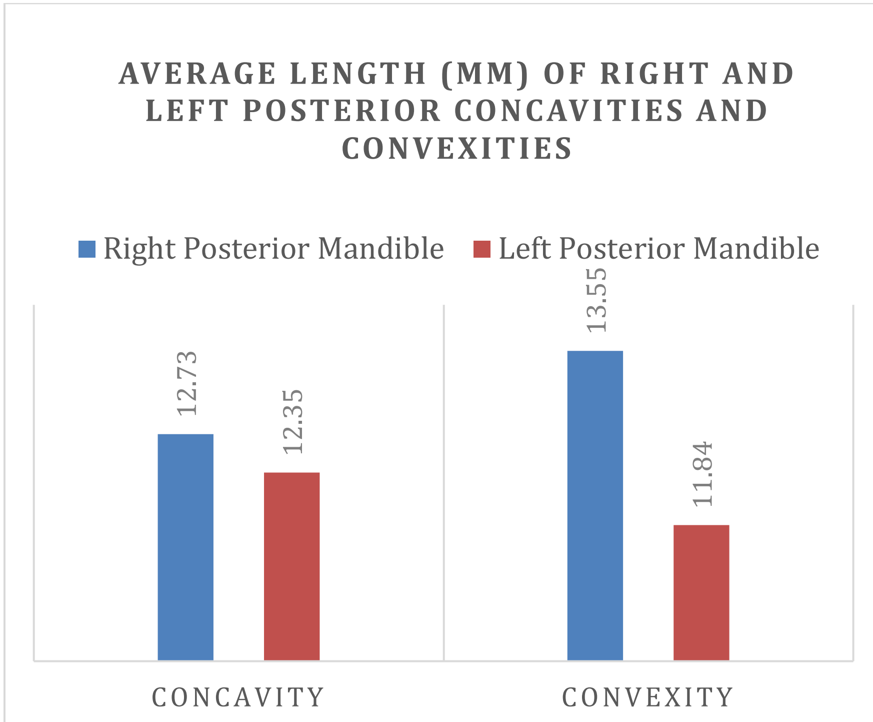


There was no significant relation between right and left posterior ridge shape with gender (right, Chi-squared=1.769, p=0.413) (left, Chi-squared=1.467, p=0.480), and racial groups (right, Chi-squared = 2.559, p=0.862) (left, Chi-squared = 5.632, p=0.466). There was a significant relation between posterior ridge shape and age (ANOVA, F=3.494, p=0.031).

The average length in millimeters of the lingual concavity was 12.73mm and 12.35mm for the right and left posterior mandible (Figure 10)

The average length in millimeters of the lingual convexity was 13.55mm and 11.84mm for the right and left posterior mandible (Figure 10).

Figure 10. Average length in millimeters of right and left posterior mandibular lingual concavities and convexities



Bivariate analysis revealed there was a significant mean difference in right and left posterior ridge length based on a history of periodontal disease (right, t-test, t=5.749, p=p=1.62e-08), (left, t-test, t=-2.469, p=0.014). There was also a significant positive correlation between right posterior ridge length and left posterior ridge length (Correlation test, R=-0.61, p=0.01).

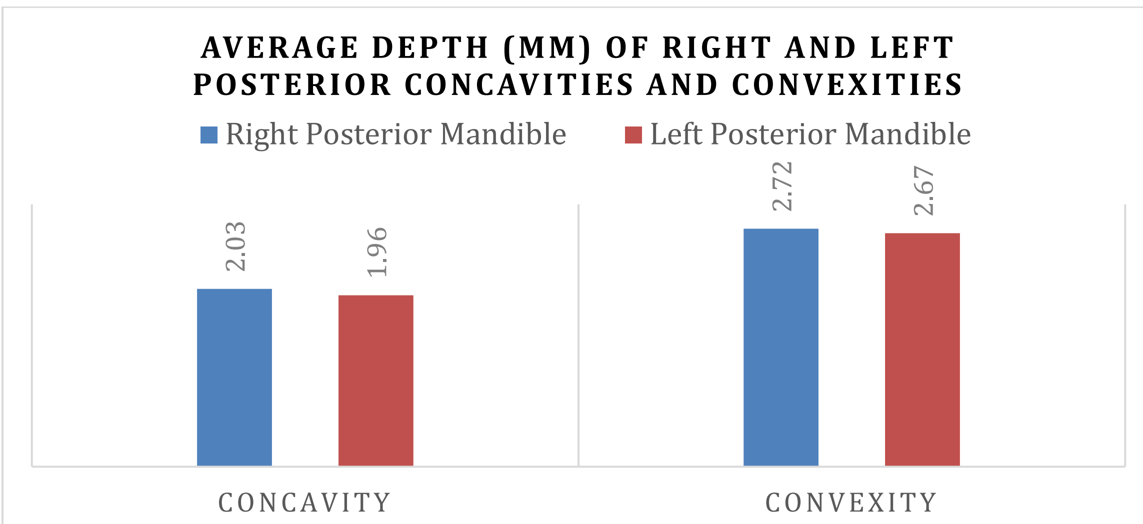
Multivariable regression analysis revealed that for every year of increase in age, there was a statistically significant decrease of 0.059 mm in the length of the right posterior concavity ridge, when controlling for factors such as gender, race, smoking status, history of periodontal disease, and dentition status (p=0.003).

In individuals with a history of periodontal disease diagnosis, there was a statistically significant increase of 3.347 mm in the length of the right posterior concavity ridge, when controlling for factors such as age, gender, race, smoking status, and dentition status (p=1.88e-08). There was also a statistically significant increase of 1.556 mm in the length of the left posterior concavity ridge, when controlling for factors such as age, gender, race, smoking status, and dentition status (p=0.007). This can imply that patients with a history of periodontal disease tend to have larger lingual concavities in terms of length for both the right and left posterior lingual mandible.

The average depth in millimeters of the lingual concavity was 2.03mm and 1.96mm for the right and left posterior mandible respectively (Figure 11).

The average depth in millimeters of the lingual convexity was 2.72mm and 2.67mm for the right and left posterior mandible respectively (Figure 11).

Figure 11. Average depth in millimeters of right and left posterior mandibular lingual concavities and convexities



According to the bivariate analysis, there was a significant positive correlation between right posterior ridge depth and left posterior ridge depth (correlation test, R=0.44, p=0.01).

The location of the posterior mandible lingual concavity was most frequently found at the right first molar site in 184 subjects (52%) followed by right second molar in 165 subjects (46%) and the right second premolar in 6 subjects (2%) (Figure 12).

The location of the posterior mandible lingual convexity was most found at the right first molar site in 188 subjects (54%) followed by right second molar in 155 subjects (45%) and the right second premolar in 4 subjects (1%) (Figure 13).

Figure 12. Location of right posterior mandibular lingual concavities (second premolar, first molar and second molar)

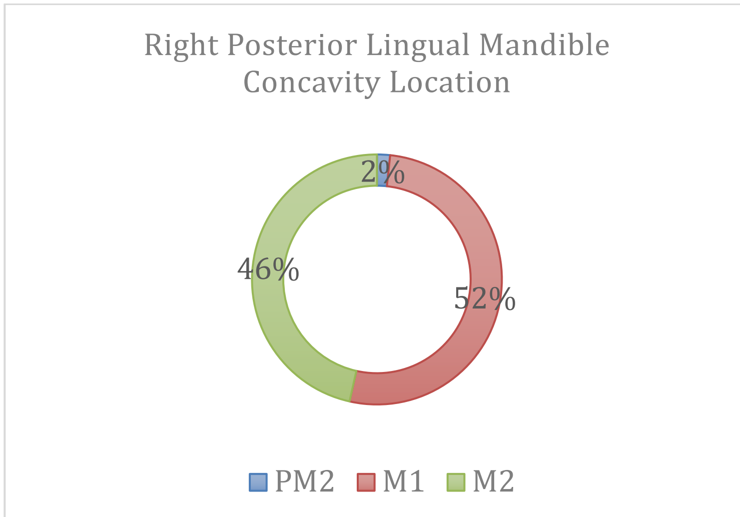
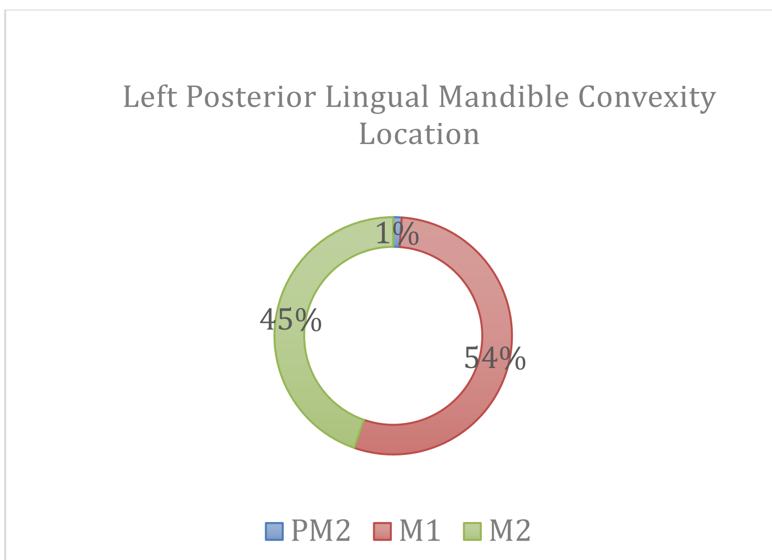


Figure 13. Location of left posterior mandibular lingual concavities (second premolar, first molar and second molar)



The low prevalence at second premolar region could be due to estimating tooth locations on edentulous and partially edentulous mandibular ridges.

According to the bivariate analysis, there was a significant relation between the right and left posterior lingual ridge location and the right/left dentition status respectively (right, Chi-squared = 40.306, p=3.967e-07) (left, Chi-squared = 40.738, p=3.261e-07). This could suggest that individuals with partially or completely edentulous ridges are more likely to have lingual concavities at the first and second molar regions.

CHAPTER 4

DISCUSSION

The prevalence of the posterior mandibular lingual concavity in the studied population was 60%. This was based on an average of prevalence between right and left concavities. Search of the current literature has suggested that the prevalence of these concavities ranges from 50.1% to 68% as documented by Nickenig et al., 2014; Kamburoğlu et al., 2015; Chan et al., 2011; Rajput et al., 2018. One study by Nickenig in 2014 found that the prevalence of lingual concavities (U-configuration posterior ridges) was 56%. This study was conducted on edentulous and partially edentulous ridges. This was similar to the prevalence found in the studied population of 60%.

There was no significant relation between right and left posterior ridge shape and gender. This is consistent with past studies that have also found no significant difference between ridge shape and gender (Nawwar, 2022) (Kivanc, 2015) (Bodart, 2020).

The study found that the average length of the lingual concavity was 12.73mm for the right posterior mandible and 12.35mm for the left posterior mandible. Of the studies that measured concavity length, a wide range of lengths were observed ranging from 10.33mm to 29.1mm (Nickenig, 2014) (Kamburoğlu, 2015). The present study measured concavity length from the most prominent aspect of the coronal lingual cortex to the most prominent aspect of the apical lingual cortex. Other studies did not measure length and simply used crest height and crest base as a marker to measure depth.

In terms of the posterior lingual convexity, there are limited studies that report length, depth and location measurements.

The study indicated that the average depth of the posterior mandibular lingual concavity was 2.03mm and 1.96mm for the right and left posterior mandible respectively. Chan et al. 2011 evaluated depth from the most prominent coronal aspect of the bone to the base of the ridge and found that the average depth was 2.4mm in 103 subjects. Rajput et al. 2018 measured depth of lingual concavities by drawing a line joining the most prominent superior and inferior points of the concavity. The depth was then recorded as the deepest point of the concavity from that line. The group found that the average depth was 2.6mm in 104 patients. Their study used a similar measurement method to the one used in this study. Kimburoglu et al. 2015 found the concavity depth range to be from 2mm to 3mm.

There were limited studies that focused on depth measurements of posterior lingual convexities.

In the study, posterior mandibular lingual concavities were found in the right first molar site in 52% of subjects and left first molar sites in 54% of subjects. There was variability within the literature on the location of the concavity. This variability could be due to subjective assessments of posterior edentulous tooth positions. Lingual concavities that were measured in edentulous sites were given an estimated tooth position in this study.

The most prominent anterior lingual convexity location was the mandibular central incisor site. The average length and depth of the anterior convexity was 19.01mm and 3.37mm respectively. There are no studies in the literature that measure the prevalence of anterior lingual convexities, location, length and depth. This study found that there was a significant relationship between anterior ridge length and depth with a history of periodontal disease. Further studies are needed in this space to determine anterior lingual convexity prevalence, location, length and depth.

Of the secondary variables measured, the study found that periodontal disease history can influence factors related to posterior mandibular concavities. There was a statistically significant increase in the length of posterior mandibular lingual concavities in patients who presented with a history of periodontal disease. This aligns with the notion that periodontal disease can cause variable patterns of bone destruction that can lead to larger concavities. There are currently no studies in the literature that assess history of periodontal disease as a parameter in tracking the presence of both anterior lingual convexities and posterior lingual concavities.

Both age and history of periodontal disease are associated with changes in alveolar crest dimensions. However, the mechanisms by which the destruction occurs are unique. For example, age-related bone loss can be more uniform leading to a decrease in ridge width which can include the lingual concavity. Periodontal disease can cause localized patterns of alveolar bone destruction potentially leading to an increase in the length of the concavity. This study demonstrated that there is an association between mandibular ridge morphology and a history of periodontal disease.

The wide range of length, depth, and location measurements for both anterior and posterior mandibular lingual concavities can be due to several reasons. There were differences in CBCT imaging systems used in all studies. These variations in the specifications of CBCT devices could lead to discrepancies in image resolution. There are also variations in the image rendering software which can affect how the practitioners interpret the images. Finally, the evaluation of scans is inherently subjective in nature. Therefore, even calibrated practitioners can exhibit variability in the interpretation of the images.

The present study had several limitations. This was a retrospective study which could limit the control over data collection. The sample was obtained from Temple University-Kornberg School of Dentistry which would make it difficult to extrapolate the findings to other demographics. There was also limited information on other variables. Since this study assessed secondary variables such as gender, ethnicity, smoking status, and history of periodontal disease, it did not consider other confounding variables such as medications or systemic health conditions. Lastly, the subjective nature of measuring CBCT renderings among the calibrated practitioners could have led to variations in the data.

CHAPTER 5

CONCLUSION

The objective of the study was to examine the morphology of anterior and posterior mandibular lingual ridges and determine the prevalence of posterior mandibular lingual concavities based on CBCTs reviewed from Temple University Kornberg School of Dentistry. The most common anterior lingual mandibular morphology in the studied population is convex (99%), with the most prominent location being the mandibular central incisor. The prevalence of the posterior mandibular lingual concavity is 60% with the most common location being the right and left first molar site. There was no significant relation between right or left posterior ridge shape and gender and age, as previous studies have proposed.

The average depth of the mandibular lingual concavity was found to be 2.03mm and 1.96mm for the right and left posterior mandible respectively. The height of the posterior mandible alveolar ridge decreases with age and periodontal disease which could suggest that lingual concavities become more pronounced over time.

CBCT imaging can improve the ability of practitioners to identify the mandibular lingual concavity and pre-plan dental implants of adequate dimensions. This may prevent complications associated with lingual concavity perforations, including potentially life-threatening hemorrhages and airway obstruction. Further research should incorporate a broader range of confounding variables (systemic health conditions, medication usage), to better understand their impact on mandibular lingual ridge morphology. Larger sample sizes and diverse populations should also be studied to validate and generalize findings related to the mandibular lingual ridge morphology.

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