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# Tomographic Evaluation of Palatal Masticatory Mucosal Thickness and Its Association with Age and Gender – A Cone-Beam Computerized Tomographic Study.

[1]Dr. Patel Ridham A.; Post graduate, Department of Periodontology and Oral Implantology, College of Dental Sciences and Research Centre, Bopal, Ahmedabad, Gujarat, India.

[2]Dr. Panchal Anita H.; H.O.D. & Professor, Department of Periodontology and Oral Implantology, College of Dental Sciences and Research Centre, Bopal, Ahmedabad, Gujarat, India.

[3]Dr. Nanavati Bhaumik K.; Reader, Department of Periodontology and Oral Implantology, College of Dental Sciences and Research Centre, Bopal, Ahmedabad, Gujarat, India.

[4]Dr. Patel Naman K.; Post graduate, Department of Oral Medicine and Radiology, College of Dental Sciences and Research Centre, Bopal, Ahmedabad, Gujarat, India.

[5]Dr. Dudhia Sonal B.; H.O.D. & Professor, Department of Oral Medicine and Radiology, College of Dental Sciences and Research Centre, Bopal, Ahmedabad, Gujarat, India.

[6]Dr. Chaudhary Harshvardhan R.; Reader, Department of Public Health Dentistry, College of Dental Sciences and Research Centre, Bopal, Ahmedabad, Gujarat, India.

**Correspondence Author:** Dr. Patel Ridham A., Post graduate, Department of Periodontology and Oral Implantology, College of Dental Sciences and Research Centre, Bopal, Ahmedabad, Gujarat, India.

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**Conflicts of Interest:** Nil

**Abstract**

**Context:** Soft tissue grafts from the palate are harvested for various periodontal plastic surgery procedures. Prior mapping of palatal mucosal thickness of individuals based on age & gender aids in treatment plan.

**Aims and Objectives:** The objective of this study was to use cone-beam computed tomography (CBCT) to perform a comprehensive analysis of the palatal mucosal thickness and its association with age and gender.

**Settings and Design:** In this study thirty patients had undergone a CBCT scan of maxillary arch using a CBCT scanner (NewTom GiANO, Italy) and it was analysed in software.

**Materials and Method:** Tomographic measurements were performed for palatal masticatory mucosal thickness at 2 mm, 5 mm, 8 mm and 12 mm from marginal gingiva for canines, premolars and molars. A comparison was made between the young (≤ 40 years) and older (>40 years) age groups and between males and females.

**Statistical analysis used:** Intragroup comparison was made using unpaired t-test.

**Results:** The average thickness of palatal mucosa was 2.90mm at canine region, 3.22mm at first premolar, 3.32mm at second premolar, 2.82mm at first molar and 2.99mm at second molar region. Statistically significant difference was noted between age groups and no significant difference was noted between males and females.

**Conclusion:** CBCT serves as a non-invasive method for evaluating thickness of palatal masticatory mucosa.

**Keywords**: cone-beam computed tomography, connective tissue graft, palatal mucosal thickness.

## Introduction

The masticatory mucosa of the palate serves as a donor material in plastic surgery. In periodontics, grafts from the palate are harvested for various plastic surgery procedures.1,2 Periodontal plastic surgery is used widely to fulfil aesthetic and functional demands. It is used for root coverage, to augment minor ridge deformities, for vestibuloplasty, for papillae reconstruction and for socket preservation.2,3 Thickness of palatal mucosa, in particular, has attracted considerable attention with regard to a possible donor site for connective tissue transplants in plastic surgery.1

In the past, palatal mucosal thickness has been measured using several methods. Physical measurement methods involve bone sounding using endodontic reamer4 and periodontal probe after local anaesthetic administration.1,5 An ultrasonic measurement is less invasive and easy to perform; however, it is technique-sensitive and less reliable, especially in thick areas.6 Till date, the most common method to evaluate the palatal mucosal thickness prior to harvest a tissue graft is to bone-sound, a precise method, but one that requires patient anesthetisation. Recently, computed tomography (CT) for measuring thickness of oral mucosa has been introduced.3,7 A major disadvantage with the use of CT is high radiation dose involved during its operation. With a lower output and a shorter exposure time, cone-beam computed tomography (CBCT) provides an accurate hard tissue assessment with a reduced radiation dose.8 For these reasons, CBCT is now the most commonly used imaging modality for implant assessment.9

Barriviera and colleagues (2009),10 reported palatal mucosal measurement using CBCT. CBCT provided an accurate assessment on mucosal tissue thickness, with the measurement value being very similar to previous reports that employed physical measurement.1,5 The primary aim of this study was to determine if the thickness of the palatal masticatory mucosa, as determined from a CBCT scan.

## Materials and Method

Thirty periodontally healthy patients (17 males; 13 females), age ranged from 20-71 years that were reported, participated in this study. This study was approved by the institutional ethical committee. Demographic representation is shown in Table 1, based on age and gender. The patients that were selected presented with complete maxillary dentition except the third molars. Patients with previous surgical intervention of the affected area, history or presence of pathology, periodontal disease, implants, orthodontic retainers and prosthetic appliances at the site of evaluation, tooth malalignment, use of any medication possibly affecting the periodontal tissues, presence of pregnancy, lactation and any systemic disease that can affect the mucosal structure in the oral cavity were excluded in this study. Cone-beam computed tomography (CBCT) scans were taken of patients that met the inclusion and exclusion criteria. CBCT scans were taken through CBCT machine (NewTom GiANO, Italy); scan time being 18 seconds with device protocols as: voxel size: 1.05 mm, grey scale: dynamic range 16 bits, focal spot: 0.5 mm, image detector: flat panel amorphous silicon; and were analysed using NewTomTM (NNT) software.

**Table 1**: Demographic representation of participants based on age and gender.

| Age group (years) | Gender | | Total |
|---|---|---|---|
| | Males | Females | |
| ≤40 | 8 | 8 | 16 |
| >40 | 9 | 5 | 14 |

During the CBCT scans, patients were seated in an upright position with their chins and head stabilized. A wooden spatula was made to bite at the posterior teeth during performing CBCT scan so as to obstruct the tongue in

**Figure 1**: Retraction of cheek and tongue as performed during CBCT using plastic cheek retractor and wooden spatula.

Touching the palate to obtain a clear palatal soft tissue profile in resultant CBCT image [Figure 1], and a plastic cheek retractor was put in place in-order to retract the cheeks that might cause the buccal soft tissues to overlap in the CBCT images. All CBCT analyses were performed by the same clinician as follows: canines, pre-molars and molars (five teeth on either side) were subjected to measurements. These measurements were performed at four different heights in the palate, i.e. at distances of 2 mm, 5 mm, 8 mm and 12 mm from the gingival margin [Figure 2].

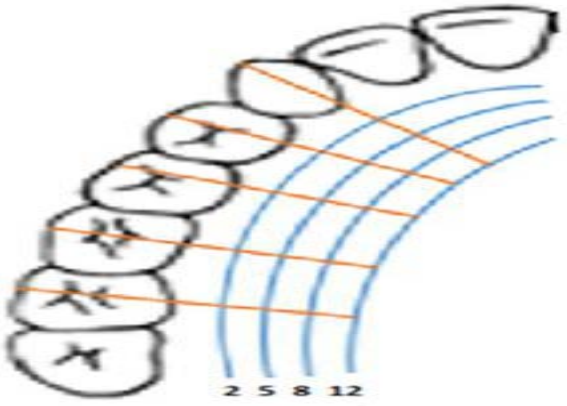



**Figure 2**: Schematic representation of measurement sites. Palatal mucosal thickness was measured on CBCT images for Canine (C); first and second premolars (P1, P2); first and second molars (M1, M2) at 2mm, 5mm, 8mm, 12mm from gingival margin.

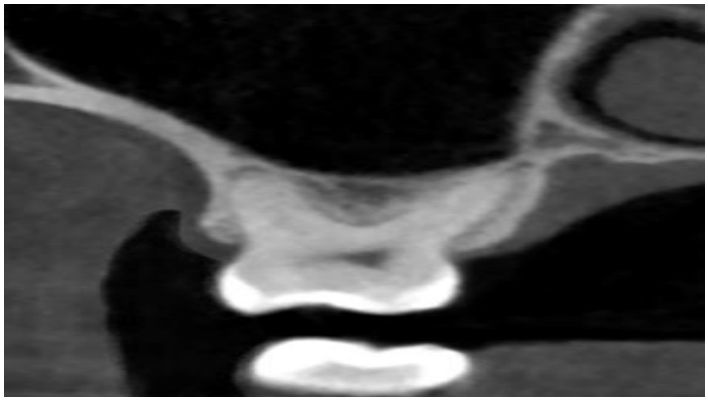


**Figure 3**: CBCT image of first molar and palatal region after retraction of tongue

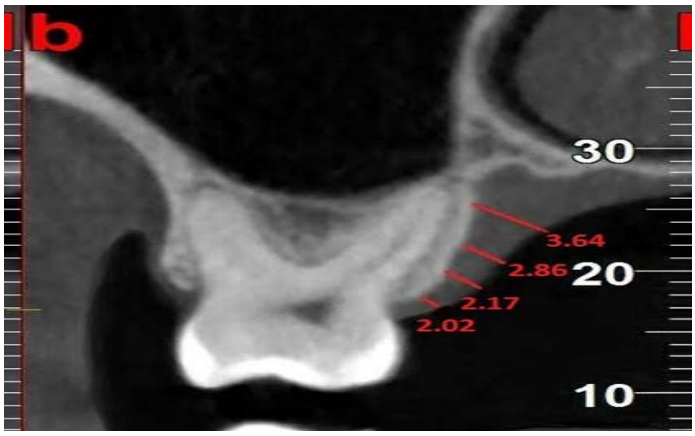



**Figure 4**: Soft tissue measurements marked for first molar in resultant CBCT scan using ruler tool in NNT software at the predetermined points, i.e. at 2 mm, 5 mm, 8 mm and 12 mm from gingival margin.

**Statistical Analysis**

Data was expressed as a measure of mean and standard deviation for all participants. Comparison of mucosal thickness between the participants of different age groups and between the genders were done at each measurement site. Statistical analysis was done using unpaired t-test in SPSS statistics for windows version 16.0. $P < 0.05$ was considered to be statistically significant.

**Results**

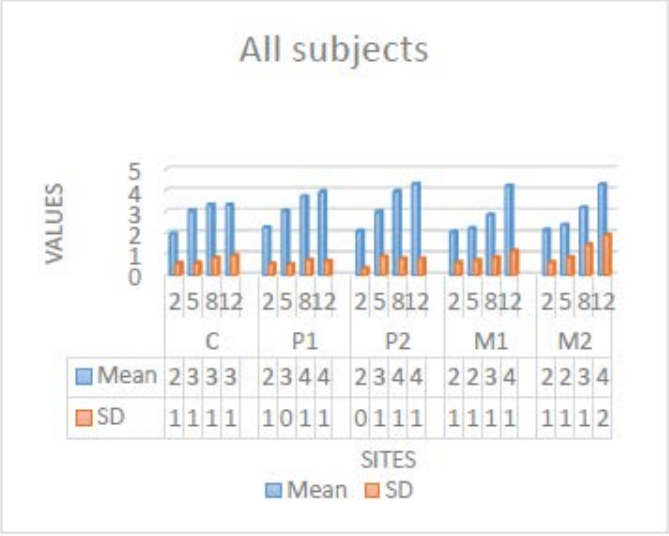
Measurement sites on either side of maxillary arch on a resultant CBCT was analysed for all subjects that participated in this study. Measurements were calculated at twenty sites per subject from the CBCT images. Table 2 shows the mean palatal mucosal thickness and standard deviations (SD) for all sites. Graph 1 summarizes the data of Table 2.Mean ± SD thickness for all subjects was found to be 2.91 ± 0.91 mm for canine, 3.21 ± 0.88 mm for first premolar, 3.33 ± 1.11 mm for second premolar, 2.82 ± 1.19 mm for first molar and 2.99 ± 1.53 mm for second molar regions. When all values were compared, the maximum thickness was observed at 8 mm and 12 mm distance compared to 2 mm and 5 mm distances from gingival margin. Highest thickness was measured at 12 mm distance of second premolar and molar regions.

Table 3 shows the comparison between males and females. Statistically significant difference ($P < 0.05$) between males and females was seen at 2 mm distance from marginal gingiva of second premolars and first molars. Also, statistically significant difference was seen at 8 mm distance from gingival margin at second molar region; and at 12 mm distance at canine, first and second molar regions. However, results were found to be statistically insignificant ($P > 0.05$) for all other measured sites. Graphical representation shown in Graph 2.

Table 2: Mean and Standard Deviation (SD) for all participants. (C, Canine; P1, first premolar; P2, second premolar; M1, first molar; M2, second molar).

| Variable | Distance (mm) from gingival margin | Mean | SD |
|---|---|---|---|
| C | 2 | 1.95 | 0.54 |
| | 5 | 3.02 | 0.55 |
| | 8 | 3.32 | 0.8 |
| | 12 | 3.32 | 0.93 |
| P1 | 2 | 2.23 | 0.51 |
| | 5 | 3.01 | 0.49 |
| | 8 | 3.7 | 0.69 |
| | 12 | 3.92 | 0.64 |
| P2 | 2 | 2.07 | 0.31 |
| | 5 | 2.97 | 0.86 |
| | 8 | 3.94 | 0.76 |
| | 12 | 4.3 | 0.75 |
| M1 | 2 | 2.02 | 0.58 |
| | 5 | 2.2 | 0.68 |
| | 8 | 2.85 | 0.83 |
| | 12 | 4.21 | 1.12 |
| M2 | 2 | 2.11 | 0.58 |
| | 5 | 2.37 | 0.83 |
| | 8 | 3.17 | 1.45 |
| | 12 | 4.27 | 1.89 |

Table 4 compares the palatal mucosal thickness between the different age groups and it showed statistically significant difference between younger (≤40 years) and elder (>40 years) groups ($P < 0.05$) for all measured sites. Graph 3 summarises data of table 4.




**Graph 1**: Shows the mean and standard deviations of all sites in all the subjects.

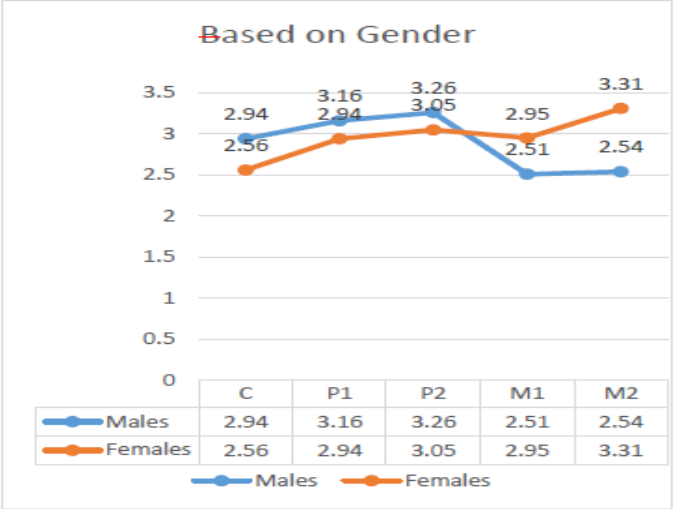
**Table 3**: Mean ± SD of palatal masticatory mucosa for five teeth and shown by respective distance from gingival

margin sorted by gender. [P<0.05=significant; P>0.05=not significant].

| Variable | Distance from marginal gingiva | Mean ± SD | | P value | Significance (S); Non-Significance (NS) |
|---|---|---|---|---|---|
| | | Males (n=17) | Females (n=13) | | |
| Canine | 2 | 2.01 ± 0.39 | 1.88 ± 0.69 | 0.517 | NS |
| | 5 | 2.97 ± 0.48 | 3.09 ± 0.64 | 0.553 | NS |
| | 8 | 3.57 ± 0.86 | 3.00 ± 0.60 | 0.052 | NS |
| | 12 | 3.71 ± 0.81 | 2.81 ± 0.83 | 0.005 | S |
| First premolars | 2 | 2.25 ± 0.57 | 2.22 ± 0.44 | 0.876 | NS |
| | 5 | 3.06 ± 0.34 | 2.95 ± 0.64 | 0.541 | NS |
| | 8 | 3.90 ± 0.77 | 3.46 ± 0.48 | 0.086 | NS |
| | 12 | 4.00 ± 0.62 | 3.81 ± 0.67 | 0.43 | NS |
| Second premolars | 2 | 1.97 ± 0.29 | 2.22 ± 0.29 | 0.025 | S |
| | 5 | 2.99 ± 1.00 | 2.96 ± 0.68 | 0.942 | NS |
| | 8 | 4.12 ± 0.87 | 3.70 ± 0.52 | 0.137 | NS |
| | 12 | 4.54 ± 0.66 | 4.01 ± 0.78 | 0.056 | NS |
| First molar | 2 | 1.93 ± 0.58 | 2.14 ± 0.57 | 0.333 | S |
| | 5 | 2.08 ± 0.65 | 2.37 ± 0.71 | 0.263 | NS |
| | 8 | 2.67 ± 0.98 | 3.09 ± 0.53 | 0.174 | NS |
| | 12 | 3.74 ± 0.85 | 4.82 ± 1.16 | 0.006 | S |
| Second molar | 2 | 2.03 ± 0.37 | 2.21 ± 0.79 | 0.42 | NS |
| | 5 | 2.27 ± 0.69 | 2.53 ± 1.00 | 0.406 | NS |
| | 8 | 2.67 ± 0.94 | 3.82 ± 1.75 | 0.028 | S |
| | 12 | 3.55 ± 1.69 | 5.23 ± 1.77 | 0.013 | S |

**Table 4**: Mean ± SD of palatal masticatory mucosa for five teeth and shown by respective distance from gingival margin sorted by age group. [P<0.05=significant].

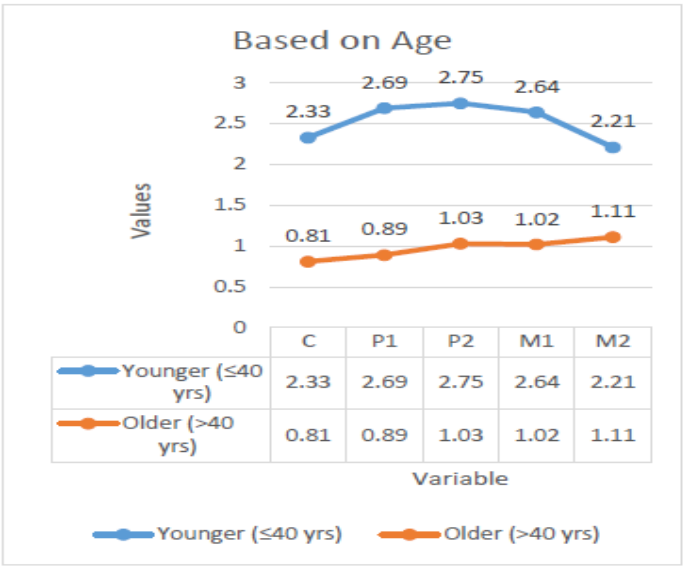
| Variable | Distance (mm) from marginal gingiva | Age group | | P value | Significance (S) |
|---|---|---|---|---|---|
| | | ≤ 40 years | > 40 years | | |
| Canine | 2 | 1.60 ± 0.34 | 2.36 ± 0.42 | 0 | S |
| | 5 | 2.68 ± 0.42 | 3.42 ± 0.40 | 0 | S |
| | 8 | 2.77 ± 0.52 | 3.95 ± 0.56 | 0 | S |
| | 12 | 2.71 ± 0.74 | 4.02 ± 0.54 | 0 | S |
| First premolars | 2 | 1.91 ± 0.36 | 2.60 ± 0.39 | 0 | S |
| | 5 | 2.69 ± 0.37 | 3.39 ± 0.31 | 0 | S |
| | 8 | 3.23 ± 0.43 | 4.26 ± 0.48 | 0 | S |
| | 12 | 3.47 ± 0.41 | 4.43 ± 0.44 | 0 | S |
| Second premolars | 2 | 1.91 ± 0.24 | 2.27 ± 0.27 | 0 | S |
| | 5 | 2.40 ± 0.59 | 3.64 ± 0.59 | 0 | S |
| | 8 | 3.43 ± 0.44 | 4.52 ± 0.61 | 0 | S |
| | 12 | 3.79 ± 0.55 | 4.90 ± 0.44 | 0 | S |
| First molar | 2 | 1.69 ± 0.46 | 2.39 ± 0.47 | 0 | S |
| | 5 | 1.77 ± 0.46 | 2.70 ± 0.54 | 0 | S |
| | 8 | 2.36 ± 0.60 | 3.42 ± 0.68 | 0 | S |
| | 12 | 3.64 ± 0.75 | 4.86 ± 1.14 | 0 | S |
| Second molar | 2 | 1.75 ± 0.45 | 2.52 ± 0.43 | 0 | S |
| | 5 | 1.84 ± 0.55 | 2.99 ± 0.63 | 0 | S |
| | 8 | 2.38 ± 0.97 | 4.07 ± 1.39 | 0 | S |
| | 12 | 3.19 ± 1.54 | 5.52 ± 1.47 | 0 | S |




**Graph 2**: Comparison between gender.

**Discussion**

This study describes a novel method in accessing the thickness of palatal masticatory mucosa using CBCT that provides reliable measurements for obtaining connective tissue from precise locations from the palate. CBCT generates 3D volumetric images and provides axial, coronal and sagittal multi-planar reconstructed images without magnification. CBCT produces a more focused beam with less radiation scatter. 11




**Graph 3**: Comparison between age groups.

In the present study it was found that the palatal mucosal thickness increased as we measured from canine to second molar except that it decreased at first molar regions near 5 mm and 8 mm from gingival margin. Mean ± SD thickness for all subjects was found to be 2.91 ± 0.91 mm for canine, 3.21 ± 0.88 mm for first premolar, 3.33 ± 1.11 mm for second premolar, 2.82 ± 1.19 mm for first molar and 2.99 ± 1.53 mm for second molar regions. Moreover, statistically significant difference was obtained between younger and older age groups but no difference was noted between males and females. Similar trends have been followed by previous studies.3,10 Thicker palatal mucosal thickness in older age groups has been attributed to the increase in thickness of orthokeratinized layer with increasing age.12

This results of this study is in accordance with study performed by Barivviera and colleagues (2009),10 who proposed a technique using CBCT scan to visualize the dimensions of palatal masticatory mucosa. They found that CBCT is a reliable method for accessing the thickness at different locations on palate.

The present study had similar results from that obtained by Wara-asapati et al. (2001)5 using transgingival probing in determination of palatal mucosal thickness.

Song et al. (2008),3 performed a study for the sole purpose of determining the thickness of mucosa in posterior palatal area using computerized tomography (CT) scan. They found that the thickness increased from canine to premolar areas, decreased in first molar region and again increased in second molar region. Moreover, significant differences were obtained between males and females, latter having thinner mucosa.

Kuriakose A et al. (2012),13 in their study to determine the thickness of the palatal mucosa by a direct clinical method, and the association of age and gender concluded that that was no significant differences between males and females; however, significant differences were found

between younger (2.40 ± 0.04 mm) and older age groups (2.56 ± 0.04 mm).

Recently, accuracy of CBCT in determining the thickness of palatal mucosa was studied by Prabhati et al. (2015).14 Statistical analysis concluded there was no significant difference between the CBCT and bone-sounding methods. Bone-sounding has been used frequently for measuring the thickness of palatal masticatory mucosa however, it is performed just at the commencement of the muco-gingival surgery and so it might hinder the treatment planning as the clinician might think that there is not enough tissue thickness available.10 Earlier other techniques have also been proposed for determining the palatal tissue thickness. Ultrasonography to capture the thickness of oral mucosa was first proposed by Kydd et al. (1971)15 Drawbacks of ultrasonography methods is that when a tranducer is placed to the tissue surface, the tissue may be compressed giving underestimation of values.

Muller et al. (2000)16 showed palatal tissue was thicker in premolar regions when compared to first molars which is consistent with results of this study. But in contrast, they found thinner palatal mucosal thickness when compared to men.

Although this study acknowledges the use of CBCT in determining palatal mucosal thickness; further more studies with larger sample size needs to be undertaken at a multicentre level in order to produce reliable results. Also, thickness of palatal mucosa is affected by body mass index (BMI),17 periodontal phenotype,16 race gender, age, etc. However, the present study showed correlations solely based on age and gender; hence scope of future studies lies in exploring other parameters for determining the palatal mucosal thickness.

**Conclusion**

Present study infers that younger age group has significantly thinner palatal mucosa when compared to older individuals. Moreover, there's no difference between palatal tissue thickness in males and females; hence this aspect can be taken into consideration during evaluation a subject that requires soft tissue grafts from palate. In conclusion, this study validates the use of CBCT as a non-invasive method for evaluating thickness of palatal masticatory mucosa for periodontal palatal soft tissue grafting procedures.

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