Surgery Research Journal
ISSN: 2768-0428

Original Article

Cone-Beam Computerized Tomography as a Tool for Greater Palatine Foramen and Greater Palatine Sulcus Detection

Luiz Carlos Magno Filho[1], Hsu Shao Feng[2], Fernado Hayashi[2], Renato Corrêa Viana Casarin[3], Vanessa Pecorari[4], Fernanda Vieira Ribeiro[3], Suzana Peres Pimentel[3], Márcio Zaffalon Casati[2,3], Fabiano Ribeiro Cirano[2,3]

[1]MSc student, School of Dentistry, Paulista University, São Paulo, Brazil
[2]PhD, Implantology Division, School of Dentistry, Paulista University, São Paulo, Brazil
[3]PhD, Periodontics Division, School of Dentistry, Paulista University, São Paulo, Brazil
[4]PhD, Statistics Division, School of Dentistry, Paulista university, São Paulo, Brazil

Correspondence
Fabiano Ribeiro Cirano.
Statistics Division, Paulista University – Address: Dr Bacelar Avenue, 1212, Vila Clementino, São Paulo, São Paulo – Zip Code: 04026-002, Brazil
Tel/Fax: 55 - 11- 5586-4000
Email: cirano.fabiano@gmail.com

- Received Date:15 May 2024
- Accepted Date: 20 May 2024
- Publication Date: 22 May 2024

Keywords
anatomy, connective tissue, computerized tomography, palate, greater palatine artery.

Abbreviations
SECTP: Sub-epithelial connective tissue from the palate; GPA: Great palatine artery; GPF: Greater palatine foramen; GPS: Greater palatine sulcus; CBCT: Cone-beam computerized tomography; CEJ: Cement-enamel junction; KVp: Kilovoltage/peak; mAs: Milli-amperage/second; µSv: Microsieverts; ICRP: International Commission on Radiological Protection; LCMF: Luiz Carlos Magno Filho; 1PM: First premolars; 2PM: Second premolars; 1M: First molars; GPN: Greater palatine nerve

Abstract
This study aimed in evaluates the position of the greater palatine sulcus and foramen, according to confounding factors, using cone-beam computerized tomography. The great palatine foramen and greater palatine sulcus were located at 105 maxillary cone-beam computerized tomography and the distance to the cement-enamel junction at the first and second premolars and the first molar were measured. A step-wise multiple regression analysis was used to data analysis. The great palatine foramen was most frequently located in the regions between the second and third molar and no influence of variables were noted ($p>0.05$). The mean distance between the greater palatine sulcus and cement-enamel junction was 15.3±2.3 mm. However, a shorter distance was observed in females ($p<0.0001$) and in those low-vault subjects ($p<0.05$). The location of the greater palatine sulcus appears to be affected by gender and palatal type, i.e., female and low-vault subjects presented the artery closer to the cement-enamel junction.

Introduction

Periodontal and peri-implant plastic surgery techniques have been widely used in daily clinical practice, with the goal of attaining esthetic excellence [1-5]. Several techniques used in plastic surgery involving the use of sub-epithelial connective tissue from the palate (SECTP) have been indicated in cases of root coverage [6-8], and peri-implant mucosal augmentation surgeries [1,3].

Although widely used, the graft removal technique should be carefully done since accidents, especially lesion of the great palatine artery (GPA), leading to severe hemorrhage can occur. GPA lesion can be painful and difficult to control, in addition to being able to favor the formation of hematomas and consequently increase the risk of infection in the site [9]. Therefore, the surgeons must be alert to and familiarized with the surgical anatomy of the palate [10,11], in addition to attempting to obtain adequate dimensions of the graft, without avoiding large safety margins that may compromise the success of the procedure [12].

The GPA emerges in the oral cavity by means of the greater palatine foramen (GPF) and has a postero-anterior trajectory, lodged in the descendant palatine, or greater palatine sulcus (GPS) [1,13]. Nowadays, clinicians locate the GPA by palpation, identifying the angle formed by the lateral wall of the alveolar process and the palatine bone, since the intersection of this angle would be the probable location of the GPA [13,14]. However, this may not be completely reliable because it is frequently not possible to locate this small bony salience, described as Benninger's palatine crest, or the greater palatine crest of the maxillary bone [14].

Therefore, the aim of this study was to evaluate the position of the GPA, identifying the trajectory of the GPS and the location of the GPF using cone-beam computerized tomography (CBCT) to identify factors influencing GPA location and to identify the secure connective tissue graft dimensions according to them.

Materials and methods

Population

A retrospective study was conducted evaluating CBCTs of patients who had sought

Citation: Filho LCM, Feng HS, Hayashi F, et al. Cone-Beam Computerized Tomography as a tool for greater palatine foramen and greater palatine sulcus detection . Surg Res J. 2024;4(2)1-6.

the services of a radiology center located in the city of São Paulo, SP, Brazil, in the period between March 2012 and January 2013. The identity of all individuals was hidden, and the study was approved by the Ethics Committee (protocol 541/11).

Sample selection was determined in accordance with the following criteria: individuals of male and female gender; minimum age of 18 years; complete dentition from the first maxillary premolars through to the second molars on the right side, with visible cement-enamel junction (CEJ) and GPS in at least one of the evaluated regions (first and second premolars, and first molar). Exclusion criteria included: individuals presenting dental restorations, the use of orthodontic bands, or fixed dentures; dental extrusion; previously submitted to orthognathic surgery in the maxilla; exams in which it was impossible to clearly determine the CEJ.

Tomographic exams

The tomographic exams were generated from the capture of images using the same appliance (i-CAT™ Cone-Beam Imaging System, Hatfield, UK) and the images were analyzed by means of a software program (i-CAT Vision™, Hatfield, UK). At the time of image capture, the patients remained seated, with the neck and head stabilized, Frankfurt plane parallel to the ground, median sagittal plane perpendicular to the ground, and eyes fixed on their own pupils reflected in a mirror placed in front of them. In addition, a wooden spatula was interposed between the maxillary and mandibular molars to prevent interposition of the tongue on the soft tissues of the palate, thus obtaining better visualization of the structures of interest. In a similar manner, a plastic mouth-opener was used with the aim of distending the vestibular mucosa, preventing it from getting in contact with the patient's teeth.

Image acquisition was performed in accordance with the manufacturer's protocol: scanning field of vision of 8 cm, voxel of 0.25 mm, exposure time of 40 seconds, 120 KVp (kilovoltage/peak), 46.72 mAs (milli-amperage/second), and radiation dose of 104.5 μSv (microsieverts), in accordance with the International Commission on Radiological Protection (ICRP).

Selection and measurement of sites

All the analyses were performed by means of a tool contained in the software, which expresses measurements in tenths of millimeters. Each region was measured separately by a single examiner, previously calibrated (LCMF – intra-class correlation test = 0.92).

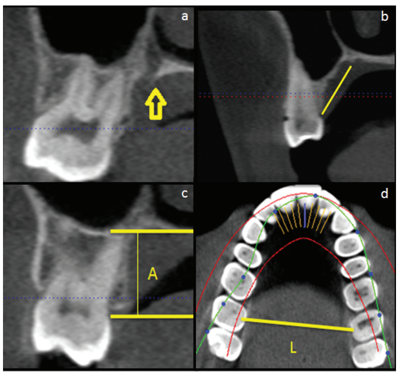

Figure 1. *a) Coronal section shows the location of GPF (arrow); b) Representative aspect of GPS location at second pre-molar; c) Determining the height of the palate; d) and width of the palate.*

Firstly, the location of the GPF was verified in each of the computerized tomography images. After this, for GPA location, the most apical limit of the GPS was considered and the distance to the CEJ at the central region of the maxillary first and second premolars (1PM and 2PM, respectively) and maxillary first molars (1M) was determined.

In addition to this, the height and width of the palate of each of the individuals were measured. To measure the height, two parallel lines were determined, one passing through the palatine bone and the other through the CEJ in the direction of the median palatine suture. The width was determined by the distance between the maxillary first molars (Figure 1). Subsequently, the depth of the palate was determined by means of the median resulting from the division of width/height. Thus, the individuals were divided into two groups, with one group being considered high palate, and the other group low palate, according to the median value of 1.72.

Result

In total, 326 CBCTs were evaluated; of these, 105 (56 male and 49 female) were selected in accordance with the inclusion and exclusion criteria, and thus composed the research sample.

To determine the variables influencing the location of the GPS (dependent variable), linear regression analysis was performed. This model can evidence the GPS location in relation to age, gender, and palatal width and depth, as well as its ratio (width/depth = determining high or low palate) (independent variables). The descriptive analysis was performed, and the assumptions of the linear regression were verified. The dispersion graphics were obtained to observe the behavior between the dependent variable with the independent variables. The Pearson and Spearman correlation tests were performed to select the variables and performed the univariate models. The collinearity was analyzed between independent variables and, when it was verified, the more significant variable was maintained. A forward stepwise selection was adopted ($p<0.25$) and the variables were analyzed regarding their r2adj results of the model, the coefficients and the statistical significance ($p \leq 0.05$). Residual diagnostics were used to test whether the regression assumptions were satisfied. An independent and blind biostatistician (VP) performed the analyses of data. Statistical analyses were performed using the software R 2.14.1. The Chi-square test was performed to analyze the association between the foramen location and age, gender, palatal width, depth, and ratio (width/depth).

Greater Palatine Foramen location

About foramen location, none of the investigated variables showed a significant correlation and consequently, no logistic regression model could be made. Table 1 shows that the two most frequent locations of the FPM were the regions between the maxillary second and third molar and at the third molar region, in both males and females (Table 1).

Table 1. *Frequency of location of the FPM.*

Location of Foramen	n (%)
3M	50 (51.0%) A
Between 2M and 3M	48 (45.7%) A
2M	7 (3.3%) B

Different letters indicates statistical significance by Chi-square test ($p<0.05$).

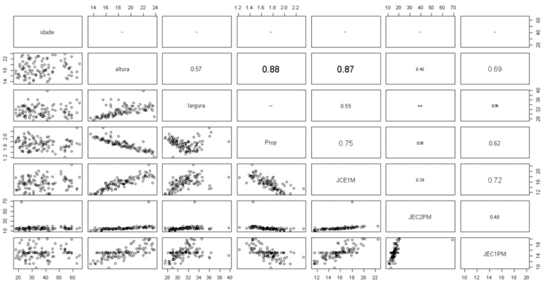

Figure 2. *Correlation matrix of the variables.*

Table 2. *Mean in mm (±SD) of the CEJ–GPS distance in each region.*

Region	CEJ–GPS distance
1st Premolar	15.5±2.3
2nd Premolar	15.5±2.3
1st Molar	14.9±2.3
p (ANOVA/Tukey)	0.137

Table 3. *Correlation test and p-values between variables.*

Variables			
Dependent (y)	Independents (x)	Correlation Coefficient	p-value
1st Molar	Age	0.1079	0.2732
1st Molar	Depth	0.8806	2.2e-16
1st Molar	Width	0.6184	2.069e-12
1st Molar	Ratio (width/depth)	-0.7528	2.2e-16

Table 4. *Correlation test between the independent variables to verify colinearity.*

Independent variables		Correl	p-value
Age	Palatal depth	0.0847	0.389
Age	Palatal width	0.0061	0.950
Age	Ratio (width/depth)	-0.0914	0.354
Palatal depth	Palatal width	0.6719	4.241e-15
Palatal depth	Ratio (width/depth)	-0.9017	2.200e-16
Palatal width	Ratio (width/depth)	-0.3329	0.00051

Table 5. *Correlation between ratio (width/depth) and gender.*

Gender	High palate (<1.71*)	Low palate (>1.71*)
Male (n=56)	34%	66%
Female (n=49)	67%	33%
p-value (Chi-square test)		0.003

Median of the ratio width/depth of palate.

GPS distance to CEJ

TThe mean distance between GPS and CEJ was 15.3±2.3 mm. Data were separate at first and second premolars, as well as the first molar region. The mean distance of each region was 15.5±2.3 mm, 15.5±2.3, mm and 14.9±2.3 mm, respectively (p>0.05; Table 2).

The Shapiro test of the variables showed normal distribution for the first molar CEJ–GPS distance (p=0.3); however, the first premolar and second premolar were not normally distributed (p<0.01). The ratio (width/depth) demonstrated normality (p=0.508) and the other variables did not show normal distribution (p<0.05). Log transformation of the data was adopted to satisfy the basic assumptions of linear regression. The correlation test performed between the variables (Table 3) indicated a statistically significant positive correlation between the first molar distance and depth (r=0.88, p<0.01) and width of the palate (r=0.61, p<0.01). The ratio (width/depth vault) presented a strong negative correlation (r=-0.75, p<0.01). There was no correlation with age (r=0.1, p=0.273); however, it was selected in the multiple linear regression as adjustment variables (Figure 2). All the modeling was performed with first molar distance (Y-variable) due the data normality and the ANOVA results, in which no difference between the 1st molars and 1st PM/2st PM distances were observed.

Furthermore, regression models to identify any variable that could influence this distance were also constructed. The collinearity analysis indicated that depth, width, and ratio of width/depth presented a significant correlation (p<0.05; Table 4). Moreover, gender and ratio (width/depth) also significantly correlated (p<0.05; Table 4).

The multiple regression analyses were modeled including the ratio of width/depth (as a significant and normally distributed variable) and age (to a better adjustment of regression model). The analyses indicate a significant negative and moderate–strong correlation (adjusted r2=0.56 – 1M) between ratio and distance of GPS to CEJ (p<0.05; Table 5), indicating that the higher the value of the width/depth ratio (i.e., lower palate), the closer the GPS will be to the CEJ, with a decrease of distance of 8.45 mm for each unit of ratio. This model of the ratio, adjusted by age, explains 56% of the variance of the GPS–CEJ distance (Table 6).

Table 6. *Model variables and multiple linear model.*

Variables		Multiple Linear model		
Dependent (y)	Independent (x)	Coefficient (β)	p-value	adjusted r2
CEJ–GPS distance 1st Molar	Age	0.0137	0.239	
	Ratio width/ depth	-8.455	2.00E-16	0.5643

Table 7. *Position of GPS with respect to vault type, measured in millimeters (mean ± sd).*

	Mean (ratio width/depth)	n	Region			p-value ANOVA/Tukey
			1M	2PM	1PM	
High-vault group (<1.71*)	1.55	53	17.2±1.7	17.0±1.9	16.3±2.0	0.07
Low-vault group (>1.71*)	1.87	52	14.1±1.7	14.2±1.6	13.5±1.5	0.2
p (Student's t test)	<0.0001		<0.0001	<0.0001	<0.0001	

* Median of the ratio (width/depth) – SD – Standard deviation

It was observed that subjects considered as high palate (53 individuals) presented a longer distance between the GPS and the CEJ for the teeth of interest, with a statistically significant difference in comparison with individuals considered as low palate ($p<0.0001$; Table 7). A mean of 16.8±1.9 mm between the GPS and the CEJ was observed for the high palate, and 13.9±1.6 mm for the low palate.

The Shapiro test of the residual values of the final model demonstrated normal distribution of the errors (Figure 3).

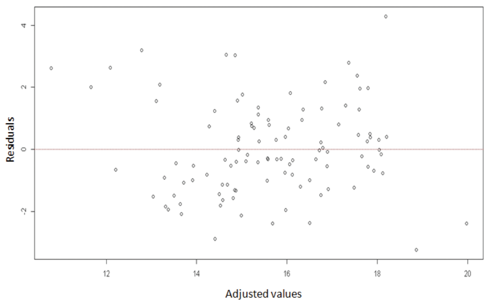

Figure 3. *Residual distribution of the multiple linear model.*

Discussion

Connective-tissue graft is widely used in periodontal and peri-implant plastic surgery [1-8], but, it demands great dexterity and anatomic knowledge and the influential variables that could determine the extent of connective-tissue graft, resulting in a well-balanced security-size ratio. To date, only anatomic studies in cadavers have been done, which directly verified the trajectory of the GPA [12-14,16,17], showing significant variations, depending on the method applied. Reiser et al.[13] conducted the first large study on the surgical anatomy of the palate, in which they observed that the GPA and the greater palatine nerve (GPN), in spite of emerging together through the GPF, followed distinct trajectories towards the anterior region of the maxilla. GPA follows a trajectory in the more lateral portion of the maxilla, which directly implicate in the SECTP removal [13,14]. Fu et al. [16] compared a method for the indirect location using plaster models and direct dissection by surgical access and concluded that there is a significant discrepancy of around 4 mm between the methods evaluated. Other authors have observed that the method of palpation was imprecise for determining the correct location of the GPA [14]. Thus, it is clear that no reliable exam can be used to determine GPA location and to indicate to clinicians the safe dimensions of SECTP.

The present study suggests a new approach to verifying the trajectory of the GPA by means of using CBCT. Thus, the GPS (where the artery lies) could be visualized directly at the area of graft. Thereby we could obtain grafts with more adequate dimensions, and with lower risk of lesion to the GPA, individualized for patient or averaging for variables.

In this analysis, it was possible to locate the presence of a canal after emergence from the GPF, and as the images were followed in the direction towards the anterior region, the formation of two sulci began to be observed, with one being located in a more medial region, while the other was located on the lateral wall of the palatine bone, confirming previous anatomic studies [13,14]. Therefore, the closer to the anterior region of the maxilla, the thinner the GPS became. This corroborates previous studies that related a gradual reduction in the diameter of the artery as it went towards the incisive foramen [16,18].

Moreover, although the GPA gets thinner, some other studies indicate that there is a tendency for the GPA to get closer to the CEJ as it goes in the direction towards the anterior region of the maxilla [13], which was not confirmed in our analysis. There were no differences between the regions of the first premolar, second premolar, and first molar, indicating a constant and linear orientation of the GPA. This facilitates the clinician's plan for graft removal, as a linear measure could be drawn, and a linear graft could be harvested.

Regarding the GPA distances to teeth CEJ, Reiser et al. [13] showed that the GPA was located at a distance that ranged from 7 to 17 mm from the CEJ of maxillary molars, and observed that the mean distance was 14.90±2.93 mm in males, and 12.70±2.45 mm in females, similar to values observed by Benninger et al. [14], who observed a distance of 9 to 16 mm. Our results showed a mean distance between the GPS and the CEJ that were higher in both males and females (16.5±2.15 mm and 14.3±1.9 mm, respectively). This fact possibly reflects the methodology used in the study, considering that previous studies were conducted in cadavers with a direct view of the GPA. In our study, although a direct view of the GPA was also allowed, our measurements were made based on the GPS itself. However, considering the GPA diameter of 2.65±1.3 mm observed by Klosek [18], similar results could be seen.

The mean distances between the CEJ and GPS for the regions of 1M, 2PM, and 1PM for males were 16.7±2.0, 16.7±1.9, and 16.0±1.8 mm, respectively, while in females, they were 14.5±1.9, 14.5±1.8, and 13.9±1.8 mm. These results agree with those described by Monnet-Conti et al. [12], who observed 16.15±2.45, 16.1±2.57, and 14.13±2.12 mm (1M, 2PM, and 1PM, respectively) in men, and 14.63±2.4, 15.05±1.84, and 13.65±1.8 for the same regions in women. Moreover, both studies observed a statistically significant difference between genders. However, besides the gender influence, the present study applied a step-wise multifactorial analysis allowing the determination of different variables on the GPS location.

The position of the GPS was evaluated about the age, gender, and palate type of individuals, and it was found that age had no influence on the position of the artery in any of the evaluated regions. Therefore, this factor presents no impact on planning surgery for SECTP removal and may suggest the immutability of the artery position as the individual ages. At the same time, gender and palatal type (low or high vault) are significant variables for GPS location.

Recently, Kim et al. [19] showed a discrete influence of gender on GPA position, with females presenting thicker palatal mucosa than males in the molar region and, inversely, thinner palatal mucosa in premolar regions. However, corroborating our results, Monnet-Corti et al. [12] showed a significant influence of gender, in which females presented a lower distance of the CEJ or alveolar crest to the GPA. Meanwhile, it is important to consider that gender could be associated with different cranial dimensions and should not be isolated enrolled in comparison between groups. Therefore, in the multiple step-wise analyses employed, gender and palate type presented collinearity and both determine the distance to the GPA.

Reiser et al. [13] classified the palate into three types: individuals with a high vault being those that present a distance of over 12 mm between the GPA and CEJ; medium vault, when this measurement ranged from 7 to 12 mm; and low vault when it was less than 7 mm. In the present study, as in a previous one [20], a dichotomization by the median value was used. It was possible to observe that individuals considered as having a high vault, irrespective of gender, presented a longer distance between the CEJ and the GPS. Therefore, in these patients, there could be a larger safety margin for tissue removal, and it may be possible to remove, when necessary, a graft with larger dimensions.

The intention of this study was to determine the anatomic characteristics and the variables influencing the position of the GPA, focusing on reducing the risk of lesion of the GPA. However, at the same time, larger safety margins would diminish the maximum dimensions of the grafts, and this could be more critical in cases of low palate or in cases in which there was a need for a larger quantity of graft [14]. Some studies tried to establish safe dimensions for SECTP. Monnet-Conti et al. [12] indicated that it may be possible to safely remove grafts from 5 to 8 mm in height in most cases, without violating the GPA. Kim et al. [19] postulated that "the premolar region is recommended as the optimal donor site for tissue grafts, and especially the second premolar region. The maximum size and thickness of tissue that can be harvested from the second premolar region are 9.3 mm and 4.0 mm, respectively". In our study, we evaluated the GPS. So, the diameter of the GPA should be considered when a clinical correlation is done.

Previous studies indicate that GPA diameters vary, ranging from 0.9 to 2.65 mm [18,19]. Considering the higher value of 2.65 mm as the GPA diameter and the distances observed in the present study, the maximum distance to the CEJ should not be more than 13.4 mm in high-vault individuals and 10.8 mm in low-vault individuals (considering the 1PM region and the elective area). This indicates that CBCT could provide an adequate analysis and location of GPA and could allow the clinician a well-recognized of safety margins, enabling, when necessary, a larger dimension for grafts.

The use of CBCT has been shown to be increasingly present in dentistry [21]. CBCT offers the dental surgeon high-quality images, making it an essential tool in dentistry. Moreover, it presents other advantages such as low morbidity, low radiation rate, reduced cost, allows the precise measurement of structures, and the possibility of evaluating both sides simultaneously [20,22,23].

The present study identified the location and variables of the palatal foramen. The GPF was most frequently located in the regions between the maxillary second and third molar, without any difference between genders. These data were similar to those observed by Klosek and Rungruang [18] and Reiser et al. [13] who more frequently located the GPF in the third molar region, and Wang et al. [24] and Fu et al. [16] who observed greater frequency of the GPF between the second and third molar (48% and 66.6% of the cases, respectively). However, Klosek and Rungruang [18] observed a difference between the genders: in men, the GPF was predominantly located in the third molar region (65%), and in women, between the second and third molars. This variation could be an effect of the method of analysis and should be confirmed in future.

Noteworthy, the limitations of this investigation are related to the characteristics of design of study - regression analysis of retrospective data - and may include confounding variables, bias and other aspects that could significantly impact the interpretation of the obtained findings. This study design presents restrict use to estimate conditions of transient nature or that progress with time, limiting inferences about causality. Thus, prospective studies with longitudinal follow-ups are important to confirm and complement the inferences of the current investigation.

In conclusion, considering the limitations of this retrospective study, the regression analyses suggest that GPF is not influenced by any characteristic and the distance of the GPS to CEJ appears to be affected by gender and palatal type, with female and low-vault subjects presenting the artery closer to the CEJ than male or high-vault individuals.

Conflict of interest statement(s), disclosure(s), and/or financial support information

The authors declare no conflict of interest. This study was self-funded by authors.

Acknowledgment

We thank Dra. Vanessa Pecorari for assisting in the completion for statistical analysis

References

1. Chiun-Lin L, Weisgold AS. Connective Tissue Graft: A Classification for Incision Design from the Palatal Site and Clinical Case Reports. Int J Periodontics Restorative Dent 2002; 22:373–379.
2. Zucchelli G, Mazzotti C, Bentivogli V, Mounssif I, Marzadori M, Monaco C. The connective tissue platform technique for soft tissue augmentation. Int J Periodontics Restorative Dent 2012; 32:665-675.
3. Esposito M, Maghaireh H, Grusovin MG, Ziounas I, Worthington HV. Soft tissue management for dental implants: what are the most effective techniques? A Cochrane systematic review. Eur J Oral Implantol 2012; 5:221-238.
4. Hsu YT, Shieh CH, Wang HL. Using soft tissue graft to prevent mid-facial mucosal recession following immediate implant placement. J Int Acad Periodontol 2012; 14:76-82.
5. Tischler M. A Maxillary Fixed Bridge Supported by Dental Implants: Treatment Sequence and Soft-Tissue Considerations. Compend Contin Educ Dent 2012; 33:340-344.
6. Langer B, Langer L. Subepithelial connective tissue graft technique for root coverage. J Periodontol 1985; 56:715–720.
7. Nart J, Valles C, Mareque S, Santos A, Sanz-Moliner J, Pascual A. Subepithelial Connective Tissue Graft in Combination with a Coronally Advanced Flap for the Treatment of Miller Class II and III Gingival Recessions in Mandibular Incisors: A Case Series. Int J Periodontics Restorative Dent 2012; 32:647-654.
8. Bittencourt S, Del Peloso Ribeiro E, Sallum EA, Nociti-Jr FH, Casati MZ. Surgical microscope may enhance root coverage with subepithelial connective tissue graft: a randomized-controlled clinical trial. J Periodontol 2012; 83:721-730.
9. Rossmann JA, Rees TD. A comparative evaluation of hemostatic agents in the management of soft tissue graft donor site bleeding. J Periodontol 1999; 70:1369-1375.
10. Griffin TJ, Cheung WS, Zavras AI, Damoulis PD. Postoperative complications following gingival augmentation procedures. J Periodontol 2006; 77:2070-2079.
11. Harris RJ, Miller R, Miller LH, Harris C. Complications with surgical procedures utilizing connective tissue grafts: A follow-up of 500 consecutively treated cases. Int J Periodontics Restorative Dent 2005; 25:449-459.
12. Monnet-Corti V, Santini A, Glise JM, et al. Connective tissue graft for gingival recession treatment: Assessment of the

maximum graft dimensions at the palatal vault as a donor site. J Periodontol 2006; 77:899-902.

13. Reiser GM, Bruno JF, Mahan PE, Larkin LH. The subepithelial connective tissue graft palatal donor site: Anatomic considerations for surgeons. Int J Periodontics Restorative Dent 1996; 16:130-137.
14. Benninger B, Andrews K, Carter W. Clinical Measurements of Hard Palate and Implications for Subepithelial Connective Tissue Grafts With Suggestions for Palatal Nomenclature. J Oral Maxillofac Surg 2012; 70:149-153.
15. Curtis JW, McLain JB, Hutchinson JA. The incidence and severity of complications and pain following periodontal surgery. J Periodontol 1985; 56:597–601.
16. Fu JH, Hasso DG, Yeh CY, Leong DJM, Chan HL, Wang HL. The accuracy of identifying the greater palatine neurovascular bundle: A Cadaver Study. J Periodontol 20011; 82:1000-1006.
17. Dridi SM, Chousterman M, Danan M, Gaudy JF. Haemorrhagic risk when harvesting palatal connective tissue grafts: a reality? PERIO 2008; 5:231-240.
18. Klosek SK, Rungruang T. Anatomical study of the greater palatine artery and related structures of the palatal vault: Considerations for palate as the subepithelial connective tissue graft donor site. Surg Radiol Anat 2009; 31:245-250.
19. Kim DH, Won SY, Bae JH, et al. Topography of the greater palatine artery and the palatal vault for various types of periodontal plastic surgery. Clin Anat 2014; 27:578-584.
20. Song JE, Um YJ, Kim CS, et al. Thickness of Posterior Palatal Masticatory Mucosa: The Use of Computerized Tomography. J Periodontol 2008; 79:406-412.
21. Scarfe W, Farman A, Sukovic P. Clinical Applications of cone-beam computed tomography in dental practice. J Can Dent Assoc 2006; 72:75–80.
22. Barriviera M, Duarte WR, Januario AL, Faber J, Bezerra ACB. A new method to assess and measure palatal masticatory mucosa by cone-beam computerized tomography. J Clin Periodontol 2006; 36:564–568.
23. Kobayashi K, Shimoda S, Nakagawa Y, Yamamoto A. Accuracy in measurement of distance using limited cone-beam computerized tomography. Int J Oral Maxillofac Implants 2004; 19:228–231.
24. Wang TM, Kuo KJ, Shih C, Ho LL, Liu JC. Assessment of the relative locations of the greater palatine foramen in adult Chinese skulls. Acta Anat 1988; 132:182-186.