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Research Article

# Soft Tissue–Cone Beam Computed Tomography: A Clinico Radiographic Study

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## Abstract

**Context:** Dimension of periodontal hard tissues and soft tissues play primary role in deciding predictability and outcome of any periodontal surgery. Advanced new techniques to assess the soft tissues, should be innovative, simple, accurate and non-invasive.

**Aims:** To compare clinical and radiological Cone Beam Computed Tomography (CBCT) analysis for evaluation of periodontal soft tissues and to determine the reliability of CBCT for this purpose.

**Methods and Material:** 54 maxillary anterior teeth of 10 periodontically healthy patients were examined clinically and radiographically. First, clinical measurements were done through transgingival probing of attached gingiva using endodontic K file with stopper and its thickness measured by vernier caliper. Radiographically, CBCT scans were taken by using plastic lip retractor, this novel technique is known as Soft Tissue-Cone Beam Computed Tomography (ST-CBCT). The measurements done were thickness of attached gingiva, distance from crest of marginal gingiva to Cemento-enamel junction (CEJ) and distance from marginal gingiva to alveolar crest. Gingival thickness by both the methods was compared.

**Statistical analysis used:** Unpaired t-test was used to check for significant difference between the two precedures ST-CBCT and transgingival probing for measuring gingival thickness.

**Results:** The use of CBCT was found to be a reliable source for assessment of periodontal soft tissues according to statistical analysis.

**Conclusions:** Inference of the present study is that ST-CBCT enhances the clinician's ability for assessment of periodontal soft tissue, renders accurate and painless diagnostic tool in comparison to only clinical assessment

**Keywords:** Gingival Biotype; Cone Beam Computed Tomography (CBCT); Soft Tissue-Cone Beam Computed Tomography (ST-CBCT); Transgingival Probing

## Introduction

Dimensions of both periodontal hard tissues and soft tissues have been critical for determining the long term success of various therapeutic approaches in esthetic dentistry. Gingival biotype is one such factor that determines the outcome of periodontal therapy, root coverage procedures and implants therapy. Gingival morphology of maxillary anterior region plays the decisive role for good esthetic outcome [1]. In 1969, Ochsenbein and Ross proposed two main types of gingival morphology, scalloped and thin or flat and thick gingiva [2]. Seibert and Lindhe categorized the gingiva into ''thick-flat'' and ''thin-scalloped'' biotypes as periodontal biotypes [3]. Claffey and Shanley defined the thin tissue biotype as a gingival thickness of <1.5 mm, and the thick tissue biotype was referred to as having a tissue thickness >2 mm [4].

Inflammation in thick biotypes results in pocket formation, whereas inflammation with thin biotypes are more prone to gingival recession [4]. Thick biotype displays more regrowth in coronal direction than in thin biotypes after crown lengthening [5]. Improper restorative preparations and margins lead to more gingival recession in thin periodontal biotype with scalloped gingival contour than with thick periodontal biotype [6]. Thickness of gingiva and underlying bone is a major contribution in the development of gingival recession during orthodontic tooth movements [7]. Gingival thickness and contour are the most influential and significant factor to predict the aesthetic outcome of an implant surgery. Thick biotypes are less susceptible to recession and have high success rate in aesthetic outcome of immediate implant therapy [8].

Gingival biotype is much essential factor in successful outcome of various root coverage procedures [9]. According to Hwang and Wang [9], there is a high association between flap thickness and complete root coverage outcomes and a critical thickness of flap >1.1 mm results in complete root coverage.

Several methods have been used to measure the thickness of gingiva, such as direct measurements [10], probe transparency (TRANS) [11], ultrasonic devices [12]. Very recently, Cone Beam Computed Tomography (CBCT) has also been used for such purpose [13]. CBCT 3-Dimentional imaging has been widely used in viewing maxillofacial region with great accuracy, low radiation dose, lower cost and high spatial resolution [14].

The aim of this study is to compare clinical and radiological (CBCT) analysis for evaluation of periodontal soft tissues. Thus the objectives of the study is to compare the thickness of attached gingiva of maxillary anterior teeth clinically and radiographically and also to determine the applicability and reliability of CBCT as a diagnostic tool for assessing periodontal soft tissue.

## Subjects and Methods

### Study population

A pilot study was conducted comprising of 10 periodontically and systemically healthy individuals, aged 18-50yrs having all the maxillary anterior teeth (canine to canine).

### Inclusion criteria

1. Subjects having all maxillary anterior teeth,
2. Maintain good oral hygiene,
3. Having no clinical signs of inflammation or attachment loss,
4. Systemically healthy individuals.

### Exclusion criteria

1. Subjects presenting periodontal pockets, gingival recession,
2. Cervical abrasion, root caries, restoration, periapical pathology,
3. Undergone any periodontal surgery or orthodontic therapy,
4. Any history of trauma to the particular tooth/ discoloration,
5. Severe malalignment,
6. If the long axis of the teeth is not in one plane (while viewing in cbct),
7. Patient taking any medication/radiation within 6 months,
8. Pregnant women or lactating mothers,
9. Smokers.

The study protocol was approved by the Ethics Committee of the Kalinga Institute of Medical Sciences and written consent was obtained from all subjects before their examinations.

### Clinical examination

Clinically gingival biotype or gingival thickness was analyzed by transgingival probing method of all the maxillary central incisors, lateral incisors and canines. Infraorbital nerve block was given by local anesthesia of lidocaine with adrenaline 1: 2, 00,000. After anaesthetizing those teeth, endodontic K file 20* with a stopper was used for transgingival probing of attached gingiva at the mid labial region, midway between the mucogingival junction and marginal gingiva. The endodontic K file was placed perpendicular to the gingiva and pierced till the bone was hit (Figure 1). The gingival thickness was measured by using vernier caliper†, caliberated in millimeter accurate up to the first decimal point (Figure 2).

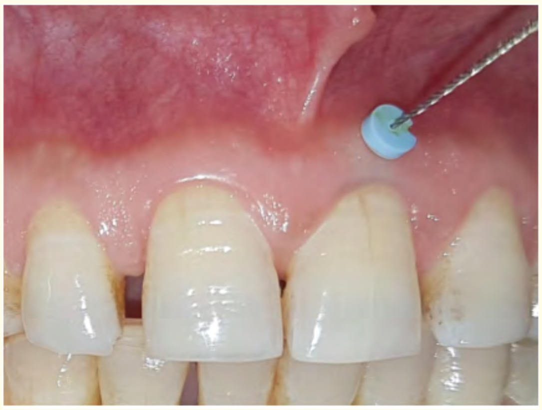

**Figure 1:** Transgingival probing with endodontic K file.

*Sybron Endo, CA, USA

†SSU Silver Vernier Caliper Range, 15 x 15 x 15 cm

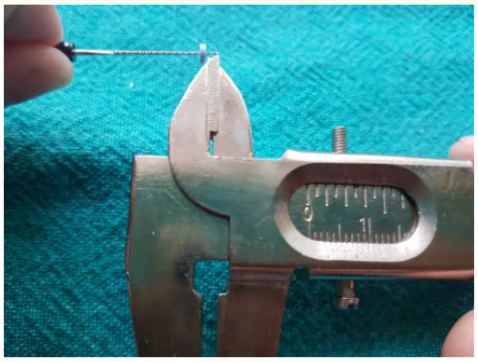

**Figure 2:** Gingival thickness measured by using vernier caliper.

### Radiographical examination

Gingival biotype and it dimensions of all the maxillary anterior teeth were analyzed by Cone Beam Computed Tomography (CBCT) of Hyperion X9 digital imaging system with NNT imaging software (v4.6) windows edition processed by computer[‡] and LCD monitor with 1280x1024 pixel resolution. At the time of CBCT scans, patients head and chin were stabilized. The occlusal plane was positioned horizontally and mid-sagittal plane was centered. A plastic lip retractor was placed in patients mouth so that the check and buccal mucosa did not touch the facial aspects of the teeth, thus allowing facial gingival to be visualized. Patients were instructed to the keep the tongue lower in the oral cavity according to the method described by Januario (2008) [13] (Figure 3) and termed it as Soft Tissue-Cone Beam Computed Tomography (ST-CBCT). CBCT scans were taken by a radiologist who was masked for the study and was unaware of the clinical examination.

**Figure 3:** Patient's head position while taking CBCT scan.

The scan was obtained only of maxilla in denture/soft tissue scanning mode of average exposure time of 11-12.3 sec taken in continuous mode at 60-65 KVp and 8-10 mA. The field of view (FOV) of the scan was 11X8 mm with 300µm resolution. For all measurements the selected teeth were viewed in cross- sectional sagittal view at the midline pertaining to the long axis of the teeth. Proper care should be taken while viewing a particular teeth, the cross sectional view i.e. from the crown till the apex, should be in one plane.

The measurement that was taken, thickness of the attached gingival mid-way between the Cemento-enamel junction (CEJ) and the alveolar mucosa (Figure 4).

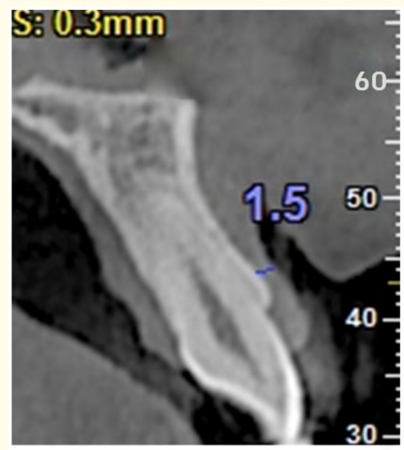


**Figure 4:** Gingival thickness measurement taken in sagittal cross sectional view of the particular teeth.

## Results

The study population consisted of 10 healthy subjects (7 men and 3 women). Out of 60 anterior teeth of the patients, 54 teeth met the inclusion criteria. All the data were subjected to statistical analysis using SSPS software version 22[§] in Windows 2010[k]. Mean values of gingival thickness and standard deviations were calculated. Unpaired t-test was used to check for significant difference between the two precedures ST-CBCT and transgingival probing for assessing gingival biotype. As per the procedure of taking CBCT scan by retracting buccal mucosa, facial gingiva can be

[‡]21 inch LCD monitor, HP L1910, Hewlett- Packard Development Co, Palo Alto, California, USA

[§]IBM, Chicago, U.S.A.

[k]ASUS E402S Series

very well seen. When viewed in cross- sectional sagittal view at the midline and long axis of the teeth, whole of the periodontium, both hard and soft tissue can be viewed easily. Table 1 shows the mean and standard deviation of gingival thickness and its comparison by two methods. On comparison of gingival thickness by transgingival probing and CBCT methods, no statistically significant difference found (P< 0.05). Figure 5 shows the graphical representation of results of Table 1. It shows that the mean of transgingival probing were higher than CBCT measurements but statistically non-significant.

| Method | n | Mean (mm) | Std. Deviation | Std. Error Mean | t | p value |
|---|---|---|---|---|---|---|
| Trans-gingival probing | 10 | 1.5200 | 0.27809 | 0.08794 | 1.759 | 0.096 |
| ST-CBCT | 10 | 1.3500 | 0.12693 | 0.04014 | | |

*Statistical significant at p<0.05.

**Table 1:** Mean and standard deviation of gingival thickness by two methods Transgingival probing and ST-CBCT.

Std. Deviation: Standard deviation

Std. Error Mean: Standard error mean

t: Unpaired t test value

p value: Test of significance

ST-CBCT: Soft Tissue-Cone Beam Computed Tomography

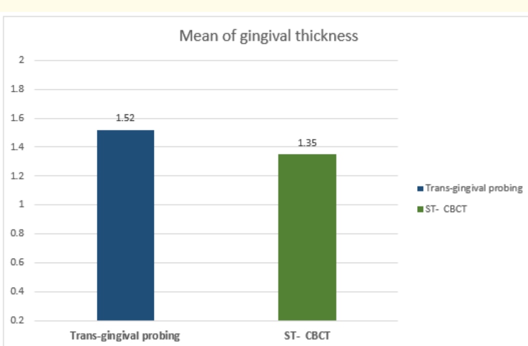


**Figure 5:** Graph of mean and standard deviation of gingival thickness by two methods Transgingival probing and ST-CBCT.

ST-CBCT: Soft Tissue-Cone Beam Computed Tomography.

## Discussion and Conclusion

The present study was conducted to determine and analyze the gingival thickness by transgingival probing and non-invasively by ST-CBCT method and to compare the differences between the two methods. It's been proven that gingiva plays a major role in progression of various periodontal diseases, mucogingival problems and the key factor for the predictable outcome of any periodontal therapy, implant therapy, orthodontic and restorative therapy especially in anterior region which is the area of major concern. That's why only anterior teeth has been included in the study and more specifically maxillary teeth which is of more aesthetic concern.

In literature, many studies have been performed to analyze the dimensions or phenotype of gingiva by various techniques. Transgingival probing was carried out as described by Muller., *et al.* [15] but used UNC-15 periodontal probe and measurements were rounded upto the nearest mm which would mislead the results. Rather endodontic K file with a stopper and measuring with vernier caliper nearest upto 0.1mm will be more accurate. This technique was conducted by Andres Pascual La Rocca., *et al.* [16], and the result of mean gingival thickness at mid facial region was 1.06 mm which is similar to the result of our study of mean 1.52 mm. The variation could be because they assessed gingival thickness of both maxillary and mandibular teeth.

Savita., *et al.* [17] investigated that gingival thickness can be measured accurately, rapidly and atraumatically by transgingival probing and ultrasonic devices. They reported a mean of 1.08mm of gingival thickness by transgingival probing and 0.86mm by ultrasonic device. A study conducted on comparison of customized digital vernier caliper with ultrasonographic devices for measurement of gingival thickness, resulted a mean of 0.56mm to 1.02mm thickness and proved that ultrasonic devices are equally comparable to that of digital caliper and also reliable in measuring gingival thickness [18], however there is difficulty to determine the correct position for attaining reproducible measurements by ultrasonographic method, and the unavailability and a high cost of the device limit the use of this method [19]. No consistent results were obtained when compared to our study with another study done by ultrasonic devices of mean gingival thickness of 0.93mm which could be due to low sample size and only anterior teeth included in our study [20].

Another very simple method to determine gingival biotype is visual inspection method. De Rouck., *et al.* in 2009, developed a new classification of gingival biotype as: thin-scalloped, thick-scalloped, and thick-flat scalloped gingival biotype [11]. But this classification is according to maxillary anterior region, mandibular parameters were not considered. Based on this classification, another study was conducted to inspect mandibular gingival biotypes and their differences with maxillary biotypes, and also checked the percentages of correct identification of gingival biotypes among clinicians. They found poor reliable identification of biotypes by experienced clinicians. More interestingly, they were having more poor responses in identifying thin scalloped biotype, which is more prone to mucogingival problems [21]. So, visual inspection cannot reproduce accurate or quantitative analysis for evaluating gingival biotype.

A parallel profile radiograph technique is a simple, reproducible, non invasive method used for measuring hard and soft tissues thickness of maxillary central incisors [22]. The mean gingival thickness in this study was 1.38mm. But this technique is limited only to the maxillary central incisors, less valid for other anterior teeth, and not for posterior teeth as it could result in superimposition of the images. Whereas, ST-CBCT could consistently reproduce gingival thickness measurements at facial surface of all the maxillary anterior teeth as well as palatal masticatory mucosa at different areas with high level of accuracy [23]. Furthermore, a single CBCT scan shows the whole maxillofacial region which further benefits for treatment planning.

Tissue biotypes of maxillary anterior teeth of human cadavers were assessed clinically and radiographically by CBCT. The resultant mean of gingival thickness by CBCT was 0.57±0.25mm and clinically by vernier caliper was 0.5±0.24mm. The study confirmed that the three- dimensional CBCT accurately represent the clinical measurements of both soft and hard tissue thickness [1].

A study done by Januario., *et al.* [13], demonstrated that both soft and hard tissues can be visualized by means of ST-CBCT with retraction of lips and cheeks, and was successfully able to measure gingival thickness and dentogingival unit. Till now, CBCT was widely used for analyzing hard tissues in maxillofacial region, but this novel approach has led to visualize and measure the dimensions of periodontal tissues (hard and soft tissues including the palatal mucosa) in a single reproducible scan.

Unlike conventional tomography, CBCT presents advantages over lower radiation, even more low radiation exposure and less exposure time in denture/soft tissue scanning mode which was carried out in our study. It presents high quality images of teeth, bone, and soft tissues with high resolution and with comfort to the patient. Unlike other non- invasive approaches to measure soft tissue i.e. direct visual method or TRAN [11,21], parallel profile radiograph technique [22], ultrasonic devices [17,18,20], radiovisiography [24], a single scan of CBCT can be analyzed at different time points without any multiple scans and multiple visits of patients. It makes convenient for treatment planning of various periodontal procedures like crown lengthening (keeping in view of dentogingival unit), implant surgery, restorative therapy, orthodontic therapy.

It is important to note that through ST-CBCT this is a quantitative and not a qualitative analysis, it cannot differentiate between the epithelial, fat and connective tissues. Inflamed, enlarged gingiva or healthy gingiva cannot be distinguished on the images. It has another drawback that through ST-CBCT periodontal structures can be only visualized on those teeth where soft tissue (lips and buccal mucosa) retraction is possible.

In summary, ST-CBCT offers a novel, non- invasive and powerful method to obtain images of periodontal soft tissues and its dimensions. Within limits of the study, ST-CBCT is equally beneficial as transgingival probing in measuring gingival thickness. This is a reliable, convenient and reproducible method in treatment planning of various periodontal surgical procedures and for other specialization.

## Bibliography

1. Fu JH., *et al*. "Tissue biotype and its relation to the underlying bone morphology". *Journal of Periodontology* 81 (2010): 569-574.
2. Ochsenbein C and Ross S. "A reevaluation of osseous surgery". *Dental Clinics of North America* 13 (1969): 87-102.
3. Seibert JL and Lindhe J. "Esthetics and periodontal therapy". In: Lindhe J, ed. Textbook of Clinical Periodontology, 2nd ed. Copenhangen, Denmark: Munksgaard (1989): 477-514.
4. Claffey N and Shanley D. "Relationship of gingival thickness and bleeding to loss of probing attachment in shallow sites following nonsurgical periodontal therapy". *Journal of Clinical Periodontology* 13 (1986): 654-657.

5. Pontoriero R and Carnevale G. "Surgical crown lengthening: A 12-month clinical gingival biotype 963 wound healing study". *Journal of Periodontology* 72 (2001): 841-848.

6. Weisgold A. "Contours of the full crown restoration". *Alpha Omegan* 7 (1977): 77-89.

7. Aziz T and Flores-Mir C. "A systematic review of the association between appliance- induced labial movement of mandibular incisors and gingival recession". *Australasian Orthodontic Journal* 27 (2011): 33-39.

8. Evans CD and Chen ST. "Esthetic outcomes of immediate implant placements". *Clinical Oral Implants Research* 19 (2008): 73-80.

9. Hwang D and Wang HL. "Flap thickness as a predictor of root coverage: A systematic review". *Journal of Periodontology* 77 (2006): 1625-1634.

10. Kan Joseph YK., *et al*. "Gingival Biotype Assessment in the Esthetic Zone: Visual Versus Direct Measurement". *International Journal of Periodontics and Restorative Dentistry* 30 (2010): 237-243.

11. Tim De Rouck., *et al*. "The gingival biotype revisited: transparency of the periodontal probe through the gingival margin as a method to discriminate thin from thick gingiva". *Journal of Clinical Periodontology* 36 (2009): 428-433.

12. Eger T., *et al*. "Ultrasonic determination of gingival thickness". *Journal of Clinical Periodontology* 23 (1996): 839-845.

13. Januário AL., *et al*. "Soft tissue cone beam computed tomography: a novel method for the measurement of gingival tissue and the dimensions of the dentogingival unit". *Journal of Esthetic and Restorative Dentistry* 20 (2008): 366-374.

14. Fourie Z., *et al*. "Accuracy and reliability of facial soft tissue depth measurements using cone beam computer tomography". *Forensic Science International* 199 (2010): 9-14.

15. Müller HP., *et al*. "Masticatory mucosa in subjects with different periodontal phenotypes". *Journal of Clinical Periodontology* 27 (2000): 621-626.

16. La Rocca AP., *et al*. "Anterior maxillary and mandibular biotype: relationship between gingival thickness and width with respect to underlying bone thickness". *Implant Dentistry* 21.6 (2012): 507-15.

17. Savitha B and Vandana K L. "Comparative assesment of gingival thickness using transgingival probing and ultrasonographic method". *Indian Journal of Dental Research* 16 (2005): 135-139.

18. Sharma S., *et al*. "Measurement of gingival thickness using digital vernier caliper and ultrasonographic method: a comparative study". *Journal of Investigative and Clinical Dentistry* 5.2 (2014): 138-143.

19. Abraham S., *et al*. "Gingival biotype and its clinical significance- A review". *The Saudi Journal for Dental Research* 5.1 (2014): 3-7.

20. Müller HP and Könönen E. "Variance components of gingival thickness". *Journal of Periodontal Research* 40.3 (2005): 239-244.

21. Cuny-Houchmand M., *et al*. "Gingival Biotype Assessement: Visual Inspection Relevance And Maxillary Versus Mandibular Comparison". *The Open Dentistry Journal* 7 (2013): 1-6.

22. Galgali SR and Gontiya G. "Evaluation of an innovative radiographic technique - parallel profile radiography - to determine the dimensions of dentogingival unit". *Indian Journal of Dental Research* 22 (2011): 237-241.

23. Barriviera M., *et al*. "A new method to assess and measure palatal masticatory mucosa by cone-beam computerized tomography". *Journal of Clinical Periodontology* 36 (2009): 564-568.

24. Mallikarjun S., *et al*. "Comparative evaluation of soft and hard tissue dimensions in the anterior maxilla using radiovisiography and cone beam computed tomography: A pilot study". *Journal of Indian Society of Periodontology* 20 (2016): 174-177.

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