Determination & Assessment of Gingival Thickness using Trans-gingival Probing & Ultrasono-graphic Methods : A Comparative Study

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Abstract

Background: A direct correlation exists between gingival thickness and susceptibility for gingival recession following surgical and restorative procedures. Attempts are being made to perform several dental procedures rapidly and atraumatically.Measurement of gingival thickness has become the matter of significant interest. Thickness of gingival tissues has been measured using various techniques like transgingival probing,vernier calipers, ultrasonography, but none of these techniques have shown to be consistent and better than others.So an accurate diagnosis of gingival tissue thickness is of importance in devising an appropriate treatment plan and achieving a predictable esthetic outcome.

Aim: The aim of the present study was to evaluate and compare the gingival thickness as measured by transgingival probing and ultrasonographic methods.

Materials & Methods: 40 systemically healthy, non-smoker individuals were included in the study. The gingival measurements were recorded from the mid-buccal and interdental papillary regions of maxillary and mandibular central incisor, lateral incisor and canine by transgingival probing and ultrasonographic methods.

Results: It was observed that the gingiva was significantly thicker in the younger age group than the older age group. In females, the gingiva was found to be thinner than that in the males and in comparison to the mandibular arch, the gingiva was thicker in the maxillary arch. It was also demonstrated in the present study that the thickness of the gingiva varies with the tooth sites, i.e. mid-buccally and interdental papillary region and also with morphology of the crown.

Conclusion: In the present study, it was concluded that the gingival thickness varies according to the age, gender, tooth morphology, site and dental arch. It was also found that in comparison to thetransgingival probingmethod, the ultrasonographic method assesses gingival thickness more accurately, rapidly and atraumatically.

Keywords: ultrasonography, transgingival probing, teeth, gingiva.

Introduction

Knowledge of the periodontal biotype orphenotype is of fundamental importanceto an oral clinician because the anatomical characteri-stics of the periodontium, such as gingival thickness, gingival width and alveolar bone morphology, will determine the behavior of periodontium when submitted to physical,chemical, or bacterial insult or during therapeutic procedures viz periodontal surgeries[1],implant[2,3], orthodontic treatment[4]. For example, a thin and delicate gingiva might be prone to developing recession after traumatic, inflammatory or surgical injuries[5].The sites where the keratinized tissue and the underlying bone appear to be thin, in those sites the orthodontic tooth movement can have detrimental effect on the muco-gingival complex[6].

The clinical appearance of the healthy marginal periodontium differs from subject to subject, giving rise to the assumption that different gingival phenotypes mightexist in any adult population[7].In literature, the thickness of masticatory mucosa has been evaluated by both invasive and non-invasive methods. The invasive method of assessing masticatory mucosa includes conventional histologyon cadaver jaws[8]while a few others used injection needle, or probe[7], histologic sections[9] or cephalometricradiographs[10].

Though the above mentioned trans-gingival probing method was invasive, non-invasive technique was performed using an ultrasonic device[11].

The advances in technology have greatly affected our day-to-day lives and the field of dentistry is no exception. Since the discovery of X-rays by Sir W.C. Roentgen in the year 1895 a great deal of advancement has been made in the field of radiology, one of which is the introduction of diagnostic ultrasonography in the field of dentistry. The increasing use of ultrasonography in the field of dentistry has established itself in almost all areas of sciences and research[12].

As the gingival thickness is gaining importance, efforts are being made to search for a method which evaluates it atraumatically and rapidly. Most of the studies conducted earlier were either carried out on edentulous patients or they estimated only the thickness of the palatalmasticatory mucosa. Studies comparing invasive and non-invasive techniques for assessing gingival thickness and establishing a correlation with site, age, gender, tooth and dental arch in the anterior segment are scarce. Hence in the present study an attempt has been made to compare the two methods of assessing gingival thickness i.e. transgingival probing and ultrasonographic methods.

Aim

The objective of this study was to assess and compare the two methods of measuring gingival thickness i.e. transgingival probing

and ultrasonographic method in Indian population and their association with site, age, gender, tooth and dental arch.

Materials & Methods

The study protocol had been reviewed and approved by the Ethical Committee of Mahatma Gandhi Dental College and Hospital, Jaipur, India. The inclusion criteria were a) healthy periodontal tissues with no loss of attachment and b) presence of all anterior teeth in both maxilla and mandible. The exclusion criteria were as follows: a) destructive periodontal diseases b) pregnancy and lactation c) gingival recession in anterior teeth region d) systemic diseases e) extensive restorations f) use of any medication affecting the periodontal tissues such as cyclosporine A, calcium channel blockers or phenytoin g) smokers.

Forty systemically and periodontally healthy subjects who reported to the Department of Periodontology and Implantology at Mahatma Gandhi Dental College and Hospital, Jaipur, India participated in this study. All the participants gave their informed consent after being briefed on the procedure. The gingival thickness was assessed in two sites- a) mid-buccally (MB) in the attached gingiva, half-way between muco-gingival junction and free gingival groove[13] and b) at the base of the interdental papilla (IDP)(Figure 1). The gingival thickness was assessed at both the sites tooth-wise i.e. at central incisor, lateral incisor and canine region in both maxillary and mandibular arches by both transgingival probing and ultrasonographic methods for each selected subject. The measurement points on the facial gingiva were marked with a water-resistant marking pencil.

Transgingival probing method

The gingival thickness was measured by anaesthetizing the facial gingiva with 2% lignocaine HCL with 1:80,000 adrenalin solutions. With the help of a UNC-15 probe, the gingival thickness wasassessed at the measurement points 5 minutes after injection (Figure 1). The measurements were rounded upto the nearest millimeter. These measurements were carried out by a single periodontist.

Ultrasonographic method

The ultrasound B-scan machine comprising of a digital display, scan display and a transducer probe was used in this study. The frequency used was 10 MHz. Each examination was performed with the subject sitting in an upright position and the mouthclosed. The region of interest was scanned using an extra-oral probe. The transducer probe was adapted to the gingival surface coinciding with the bleeding point created during transgingival probing method (Figure 2). Measurements were made directly on the screen at the time of scanning and were recorded to the nearest 0.1mm (Figure 3, 4). The measurements were carried out by a single experienced radiologist.

Statistical analysis

't'- test and paired 't'-test were applied for statistical analysis of the data.

Results

The present study included forty systemically and periodontally healthy subjects (20 males; 20 females; age range of 19-30 years). A total of 960 sites were assessed in the anterior region of the oral cavity with maximum of 24 sites for each selected subject. The measurements were recorded according to age, gender,site, tooth-wise and dental arch wise and the results were as follows:-

1) The younger age group (between 19 to 24 years) consisted of 20 subjects with a mean age of 22 years, whereas the older age group (between 25 to 30 years) consisted of 20 subjects with a mean age of 28 years. Age wise comparison of gingival thickness between transgingival probing (TGP) and ultrasonographic (USG) methods at both the sites indicated that the gingiva was significantly thicker in the younger age groups than the older age group (Graph 1,2).
2) Gender wise comparison indicated that the female subjects had thinner gingiva than males at the mid-buccaland interdental papillary region when assessed by both the methods (Graph 3,4).
3) Site wise comparison showed that the thickness of gingiva was greater in the canine region at midbuccal site followed by lateral incisor and central incisor in the maxillary arch as measured by both the methods. In the mandibular arch, the sequence found in decreasing order was canine followed by lateral incisor and central incisor when measured by ultrasonographic method. At interdental papillary region, the thickness of gingiva was greater in the canine followed by lateral incisor and central incisor by both the methods(Graph 5, 6, 7) (Table 1, 2).
4) Tooth wise comparison indicated that thickness of gingiva varied between the central incisor, lateral incisor and canine region. The difference between the two methods was found to be significant both at the mid-buccal and inter dental papillary region, but the differences were insignificant at mandibular central incisor and lateral incisor at the mid-buccal site. At the inter dental papillary region, the differences were insignificant at mandibular lateral incisor and canine(Graph 5, 6, 7) (Table 1, 2).
5) On comparing the gingival thickness dental arch wise by both the methods, maxillary arch showed a thicker gingiva both at mid-buccal as well as inter dental papillary site as compared to the mandibular arch but the differences were insignificant at central and lateral incisors at mid-buccal site (Table 1, 2).

Discussion

The gingiva is that portion of the oral mucous membrane which, in a complete post-eruptive dentition of a healthy individual surrounds and is attached to the teeth and the alveolar processes. Normally, there is considerable variation in both width and thickness of the gingiva, a fact that gives rise to the assumption that numerous gingival biotypes might exist in any adult population[5]. The clinical appearance of healthy gingiva differs from subject to subject and even among different tooth types. Many features are genetically determined; others seem to be influenced by tooth size, shape and position and biological phenomena such as gender, growth and age. Historically, few authors have discussed the importance of 'thick versus thin' gingiva in restorative treatment planning and their different pathological responses when subjected to inflammatory, traumatic, or surgical insults. Thick gingival tissue is probably the representation most associated with periodontal health in which the tissue is dense in appearance with a fairly large zone of attachment and relatively thick underlying osseous forms. The gingival topography is relatively flat with the suggestion of a thick underlying bony architecture. Thin gingival tissue tends to be delicate, friable and almost translucent in appearance with a minimal zone of attached gingiva. The osseous architecture associated with this gingival tissue type is characterized by fenestration and dehiscence[14].

Various studies have concluded that gingival thickness plays a vital role in development of muco-gingival problems, in the success of treatment for recession[15], flap management during regenerative surgical procedures[13]and also is a significant predictor of clinical outcome of root coverage procedures[15].If gingival tissues are different for thick and thin tissue biotypes, it seems logical that these distinctions would significantly influence periodontal therapy, orthodontic tooth movement and implant site preparation hence the assessment of gingival thickness is gaining a large momentum[14].

Studies comparing invasive and non-invasive methods of assessing gingival thickness are limited. Hence, an attempt has

been made in the present study to assess and compare the gingival thickness by two different methods i.e. trans-gingival probing and ultrasonographyand evaluate their comparison in association with site, age, gender, tooth and dental arch wise in Indian population.

In this study, the ultrasonographic measurements were done using a B-scan probe and by placement of straight ultrasonic probe tip in the anterior segment. The close adaptation of probe delivers ultrasonic waves at right angle to the tissues to be measured in the facial gingiva of anterior teeth. The frequency of B-scan was 10MHz. In a study conducted by Savitha B et al (2005)[11], the authors used a A-scan probe with the frequency of 10MHz, higher than SDM device used by Muller (2000) (5MHz)[16]. Eger et al (1996)[17] measured the thickness of attached gingiva using a commercially available A-mode, intraoral ultrasonic device and reported that the validity and reliability of measuring gingival thickness with the ultrasonic device was found to be excellent.

A study was conducted by Tsiolis FI et al (2003)[18] to investigate high-frequency ultrasound imaging for periodontal assessment using a newly developed ultrasonic scanner with a frequency of 20 MHz in pig jaws. Three teeth per jaw were imaged with the scanner and duplicate measurements were made of the distance from a fixed landmark on the teeth to the alveolar bone crest. These measurements were compared to transgingival probing and direct measurements of the same teeth following reflection of the soft tissues and concluded that the ultrasound measurements showed better repeatability than either of the other two methods. Also, ultrasound was in better agreement with direct, open probing measurements than transgingival probing with direct measurements.

In the present study, both transgingival probing and ultrasonographic measurements were reliable in measuring the gingival thickness, in mid-buccal and interdental papillary region unlike the study conducted in thirty two periodontally healthy subjects by Savitha B et al (2005)[11], in which authors concluded that ultrasonographic measure-ments were not dependable in papillary region.

Gingival thickness at both sites, i.e. midbuccal and interdental papilla, was thicker in the younger age group than the older age group. Similar results were found in the study conducted by Savitha B et al (2005)[11], in which the authors concluded that the thicker gingiva in the younger age group than the older age group might be because of changes in the oral epithelium caused by age, related to thinning of the epithelium and diminished keratinization. There may be other confound-ing factors such as racial and genetic factors that need to be investigated further.

Gender wise comparison concluded that the female subjects had thinner gingiva than males at the midbuccaland interdental papillary region. The results of the present study were consistent with the studies of Savitha B et al (2005)[11] and Muller (2000)[16].

Tooth wise comparison of gingival thickness between the two methods showed that gingival thickness varied between the central incisor, lateral incisor and canine. The difference between the two methods was found to be significant both at the mid buccal and interdental papillary region, but the differences were insignificant at mandibular central incisor and lateral incisor at the midbuccal site. At the interdental papillary region, the differences were insignificant at mandibular lateral incisor and canine. As observed in the present study thickness of gingiva varied with the teeth i.e. central incisor, lateral incisor and canine indicating that thickness of gingiva is dependent on the type of teeth. Muller (2000)[16]confirmed in a study that the thickness of the gingiva varies with the morphology of the crown.

However in the present study it was observed that the thickness of gingiva was greater in the canine region at midbuccal site followed by lateral incisor and central incisor in the maxillary arch as measured by both the methods. In mandibular arch the sequence found in decreasing order was canine followed by lateral incisor and central incisor when measured by ultrasonographic method. At interdental papillary region, the thickness of gingiva was greater in the canine followed by lateral incisor and central incisor by both the methods. The results of the present study were inconsistent with the results of the study done by Savitha B et al (2005)[11] in which the gingival thickness was greater in the canine by transgingival probing method.

On comparing the gingival thickness dental arch wise by both the methods, maxillary arch showed a thicker gingiva at both the midbuccaland interdental papillary site as compared to the mandibular arch. This is in contrast to the results of Savitha B et al (2005)[11], who found the gingiva to be thinner in the maxillathan in the mandible at both the sites as assessed by transgingival method.

Limitations of the study

The study could have recruited more subjects which can enhance the validity of the study. Because of this limitation, the present results should be viewed as preliminary. However, more research is needed to validate these claims.

Conclusion

The need of the hour is to carry out the dental investigatory procedures atraumatically, rapidly, and rather inexpensively. The present study attempted to address this need of the hour by comparing the two methods for the assessment of gingival tissue thickness with transgingival probing and ultrasonography methods. It was concluded that ultrasonography method might be a step towards continuing to learn and improve the care we offer to our patients as the thickness of gingival tissue is assessed more accurately, rapidly and atraumatically as compared to transgingival probing method. Every tiny bit of tissue is precious and with these recent measures like ultrasonography technique we can attempt to preserve them even better.

Considering the success of ultrasound imaging in medicine, the use of ultrasound technology in dentistry seems especially promising. From a practical point of view, the device can expand our diagnostic scope like in periodontal treatments, in oral implant and plastic surgery, and during orthodontic therapy. As ultrasound technology advances, researchers remain hopeful that ongoing studies will provide the information necessary to further develop existing applications.

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Illustrations:

Figures:

Fig 1: Intra-oral photograph depicting transgingival probing method using a UNC-15 probe at central incisor, lateral incisor and canine tooth region at mid-buccal and interdental papillary sites.

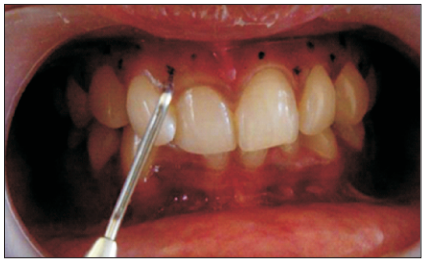


Fig 2: Ultrasonic measurements using ultrasound B-scan (Philips HT-11). The region of interest was scanned by an extra-oral probe. The transducer probe was adapted to the gingival surface coinciding with the bleeding point created during trans-gingival probing method

Fig 3: Ultrasonogram of maxillary anterior region.

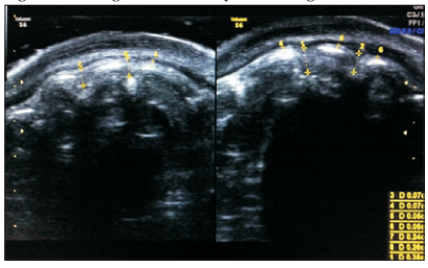
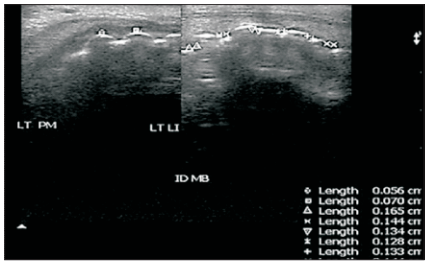
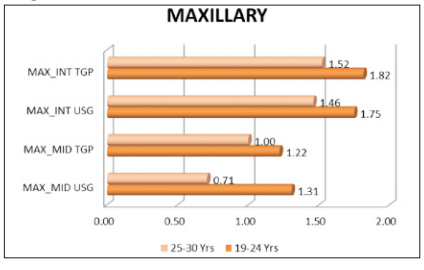


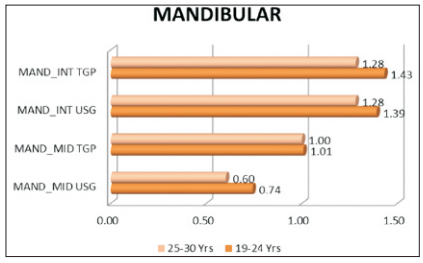
Fig 4: Ultrasonogram of mandibular anterior region.



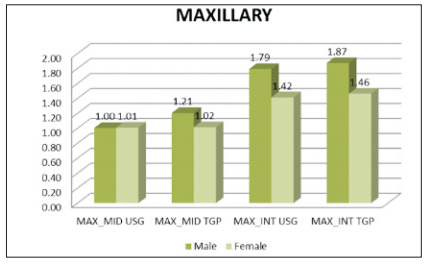
Graphs:



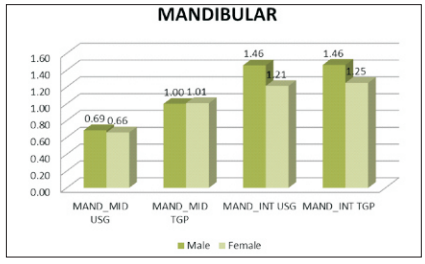
Graph 1: Mean gingival thickness in millimetres between the younger (19-24 years) and older (25-30 years) age group mid-buccally and at interdental papillary region in maxillary arch.



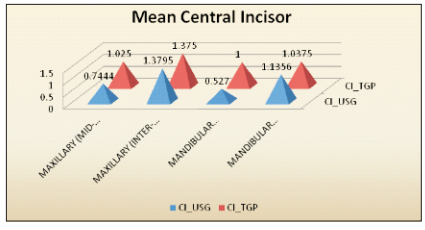
Graph 2: Mean gingival thickness in millimetres between the younger (19-24 years) and older (25-30 years) age group mid-buccally and at interdental papillary region in mandibular arch.



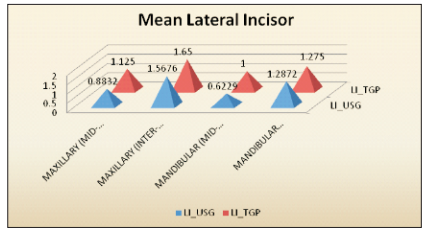
Graph 3: Mean gingival thickness in millimetres between male and female subjects in maxillary arch.



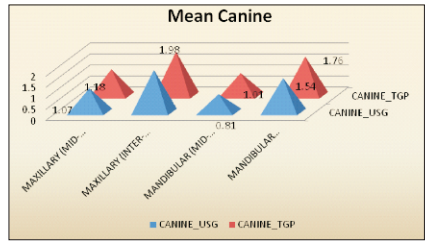
Graph 4: Mean gingival thickness in millimetres between male and female subjects in mandibular arch.



Graph 5: Mean gingival thickness in millimetres of maxillary and mandibular central incisors at mid-buccal and interdental papillary region measured by ultrasonographic (USG) and transgingival probing (TGP) methods.



Graph 6: Mean gingival thickness in millimetres of maxillary and mandibular lateral incisors at mid-buccal and interdental papillary region measured by ultrasonographic(USG) and transgingival probing (TGP) methods.



Graph 7: Mean gingival thickness in millimetres of maxillary and mandibular canines at mid-buccal and interdental papillary region measured by ultrasonographic(USG) and transgingival probing (TGP) methods.

Tables:

Table 1:Tooth wise comparison of transgingival probing (TGP) and ultrasonographic (USG) measurements at midbuccal site in maxillary and mandibular arches.

	Group	N	Mean	Std. Deviation	p-value
CI_USG	MAXILLARY (MID BUCCAL)	80	0.74	0.29	<0.001
	MANDIBULAR (MID BUCCAL)	80	0.53	0.17	
CI_TGP	MAXILLARY (MID-BUCCAL)	80	1.03	0.16	0.157
	MANDIBULAR (MID-BUCCAL)	80	1.00	0.00	
LI_USG	MAXILLARY (MID BUCCAL)	80	0.88	0.30	<0.001
	MANDIBULAR (MID-BUCCAL)	80	0.62	0.13	
LI_TGP	MAXILLARY (MID-BUCCAL)	80	1.13	0.33	0.001
	MANDIBULAR (MID-BUCCAL)	80	1.00	0.00	
CANINE_USG	MAXILLARY (MID-BUCCAL)	80	1.06	0.33	<0.001
	MANDIBULAR (MID-BUCCAL)	80	0.81	0.21	
CANINE_TGP	MAXILLARY (MID-BUCCAL)	80	1.19	0.39	<0.001
	MANDIBULAR (MID-BUCCAL)	80	1.01	0.11	

Table 2: Tooth wise comparison of transgingival probing (TGP) and ultrasonographic (USG) measurements at interdental papillaryregion in maxillary and mandibular arches.

	Group	N	Mean	Std. Deviation	p-value
CI_USG	MAXILLARY (INTER-DENTAL)	80	1.3795	0.32067	<0.001
	MANDIBULAR (INTER-DENTAL)	80	1.1256	0.17884	
CI_TGP	MAXILLARY (INTER-DENTAL)	80	1.375	0.45718	<0.001
	MANDIBULAR (INTER-DENTAL)	80	1.0375	0.19118	
LI_USG	MAXILLARY (INTER-DENTAL)	80	1.5676	0.31718	<0.001
	MANDIBULAR (INTER-DENTAL)	80	1.2872	0.22309	
LI_TGP	MAXILLARY (INTER-DENTAL)	80	1.65	0.47998	<0.001
	MANDIBULAR (INTER-DENTAL)	80	1.275	0.44903	
CANINE_USG	MAXILLARY (INTER. DENTAL)	80	1.9165	0.33513	<0.001
	MANDIBULAR (INTER-DENTAL)	80	1.5482	0.23582	
CANINE_TGP	MAXILLARY (INTER. DENTAL)	80	1.9875	0.2974	<0.001
	MANDIBULAR (INTER. DENTAL)	80	1.7625	0.42624	