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Original Research Article

Influence of ternion of soft tissue attributes on gingival recession and root coverage outcome – A retrospective analysis

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ABSTRACT

Background: The independent influence of Keratinized Tissue Width (KTW) and Gingival Biotype (GB) on root coverage outcomes have been reported over the years. These parameters along with Recession Depth (RD) might act as a triad and assessing this ternion would be beneficial in determining prognosis and devising treatment plan for gingival recession. The aim of this retrospective analysis is to evaluate a possible association between KTW, GB and RD and their influence on Gingival Recession and root coverage outcome.

Materials and Methods: 45 isolated gingival recession defects were assessed for KTW (<2mm, >2mm), GB (thin vs thick) and RD (1-4mm). Primary outcome was to establish an association between the above-mentioned parameters. Secondary outcome was to find the percentage Root Coverage (%RC) obtained after coronally advanced flap procedure. To evaluate the relationship of KTW vs GB, GB vs RD and KTW vs RD, chi-square test was used. To analyse the intra-parametric correlation and the association between all three parameters, Pearson correlation test and ANOVA were carried out respectively.

Results: The Chi-square test results revealed a statistically significant association of $p<0.03$ for the relationship of KTW vs GB and GB vs RD and $p<0.001$ for KTW vs RD. Pearson correlation test showed a positive correlation between KTW and GB (.320), negative correlation between GB and RD (-.046), and KTW and RD (-.136). ANOVA showed a p-value of 0.041 inferring that any change in KTW and GB significantly influenced RD. Sites with <2mm KTW, thin GB and deeper RD, which can be referred to as negative ternion, exhibited 43.8% mean RC while sites with >2mm KTW, thick GB and shallow RD, which can be referred to as positive ternion had 94.7% mean RC.

Conclusion: There is a definitive association between Keratinized Tissue Width, Gingival Biotype and Recession Depth. A ternion of these parameters greatly influences the outcome of root coverage procedures.

1. Introduction

Gingival Recession (GR), the commonplace clinical manifestation of periodontitis, though mostly asymptomatic is governed by various parameters such as: Keratinized Tissue Width (KTW), Gingival Biotype (GB), Recession Depth (RD), presence of Frenal Pull, Cervical Abrasion, Recession Width, Vestibular Depth, Trauma from Occlusion and Tooth Position.[1] The impact of the above said parameters on Root Coverage (RC) outcomes has long been investigated.

Keratinized gingiva comprises of attached gingiva and free marginal gingiva. The functional relevance of attached gingiva relates to its firm attachment to the underlying bone which prevents deflection of the free marginal gingiva caused by the effects of lip musculature and frena, and thus limits plaque accumulation in that zone. The necessity of certain minimum width of keratinized gingiva for the

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maintenance of periodontal health and stable post-surgical clinical attachment levels has been debated over decades.[2] Fundamental to the question of this adequacy is the association between the dimension of keratinized gingiva and gingival inflammation. *Lang and Loe* (1972) had stated that sites with <2mm of keratinized gingival tissue are less resistant to inflammation and trauma.[3] This statement holds good even after three decades and hence a minimum of 2mm of keratinized tissue which includes 1mm of attached gingiva is considered a requirement to maintain periodontal health, especially in patients with inadequate plaque control efficiency.

Correct assessment of GB is crucial as it is an important parameter in the decision tree for mucogingival procedures.[4] Inflammatory lesion which develops in response to subgingival plaque occupies the connective tissue adjacent to the dentogingival epithelium. When the free gingiva is voluminous, the inflammatory infiltrate will occupy only a small portion of the connective tissue; however, if it is thin, the entire connective tissue may be involved. In the latter case, the onset of the inflammatory lesion will lead to the obliteration of the vascular supply and, consequently, to the degeneration of the connective tissue by the proliferation of epithelium. The zone of connective tissue decreases and is obliterated by the fusion of oral and sulcular epithelium which is clinically manifested as recession. Thus, in the presence of plaque-induced inflammation, a thin marginal soft tissue is more susceptible to complete breakdown than a thick one.[5]

Sites with greater initial RD, usually exhibit a difficulty in advancing the flap coronal to cemento-enamel junction thereby resulting in tension, and an inability to achieve passive adaptation of the flap.[6] Outcomes of root coverage procedures are affected by the post-surgical position of flap which in turn is dependent on the initial RD.[2,6] Shallow defects at baseline have reported to have better RC outcomes when compared to deeper defects.[6,7]

KTW, GB and RD independently have been proposed as the predictors for RC.[8,9] Inadequate KTW and greater initial RD are reported to limit the tension free advancement of flap. Subjects with thin GB respond with less resistance to periodontal inflammation and may display deeper GR than those with a thick GB and an initial gingival thickness over 1.1mm may be a crucial factor for predictable RC.[10] The co-dependence of KTW and GB with RD might act as a 'ternion' i.e., triad and thus influence the outcomes of RC. (Figure 1)

Coronally Advanced Flap (CAF) is one of the most experimented techniques in periodontal research related to the management of GR.[11] It is a widely accepted technique that delivers predictable outcomes for isolated recession defects and has the advantages of being a straightforward procedure with less morbidity to the patient, resulting in a reliable and organic aesthetic outcome.[12]

To the best of our knowledge this is the first study to analyse the ternion of KTW, GB and RD, with the rationale of establishing their correlation in determining the outcomes of RC after CAF in isolated gingival recession. The aim of this article is to uncover the relationship between Keratinized Tissue Width, Gingival Biotype and Recession Depth and determine its influence on Gingival Recession and the outcome of root coverage after CAF.

2. Materials and Methods

2.1. Study design

This research was designed as a retrospective study. Patients who underwent root coverage procedures for isolated gingival recession by CAF between January 2022 and August 2022 in the Department of Periodontics, Ragas Dental College, Chennai were considered for this study. Patients with pre- and post-operative data and photographic records from baseline till all follow-up appointments up to at least 6 months were recruited in the study. Thus 45 recession defects in 30 patients fulfilling the inclusion criteria were identified and included in the study. This study was approved by the Institutional Ethics Committee of Ragas Dental College and conducted in accordance with the Code of Ethics of the World Medical Association (Declaration of Helsinki) for experiments involving humans.

2.1.1. The criteria for inclusion were as follows

1. Patients with class I or II Miller's defect treated with CAF
2. Age between 18 and 60 years
3. Non-smokers
4. Systemically healthy subjects

2.1.2. The criteria for exclusion were as follows

1. History of previous periodontal plastic surgery at the affected site
2. Intake of medications which impede periodontal tissue health and healing
3. Medical contraindications for periodontal surgical procedures
4. Pregnancy and lactation

2.2. Defect Characteristics

1. Presence of isolated recession with Miller class I and/or II[13]
2. Absence of Non-Carious Cervical Lesions (NCCLs)
3. Detectable Cementoenamel Junction (CEJ) at the defect sites

2.3. Outcome measures

2.3.1. Primary outcome measures

To determine the association between Keratinized Tissue Width, Gingival Biotype and Recession Depth

2.3.2. Secondary outcome measure

To assess the percentage Root Coverage (% RC)

2.4. Clinical parameters

The following parameters were measured using a University of North Carolina-(UNC) 15 probe (Figure 2).

1. Keratinized Tissue Width was evaluated as the distance between mucogingival junction (MGJ) and gingival margin using functional method and categorized as <2mm and >2mm [3,14]
2. Gingival Biotype was classified based on the translucency of probe at the midfacial aspect of the teeth, as thin at sites where the probe was detectable through the tissue (score 1) and thick where there was no visibility of the probe (score 2). [15]
3. Recession Depth was measured from the CEJ to gingival margin. RD <2mm were categorized as shallow RD and >2mm were categorized as deeper RD
4. Percentage Root Coverage was assessed using the formula:
   Pre-operative RD – Post-operative RD / Pre-operative RD x 100

2.5. Brief note on Surgical Procedure

CAF was done according to the technique proposed by *DeSanctis and Zucchelli, 2007.* [16] Briefly, two horizontal bevelled incisions followed by two slightly divergent vertical releasing incisions were given. A split-full-split thickness flap was elevated and the root surface mechanically debrided using Gracey curettes. The interdental papillae coronal to the horizontal incision were de-epithelialized to create a connective tissue bed. The flap was then advanced and positioned 1mm coronal to CEJ and secured with 4-0 resorbable sutures. Post-operative instructions and medications were given.

3. Statistical Analysis

Statistical analysis was performed using the SPSS (SPSS, Version 24.0) software. To evaluate the relationship of KTW vs GB, GB vs RD and KTW vs RD, chi-square test was used. To analyse the intra-parametric correlation and the association between all three parameters, Pearson correlation test and ANOVA were carried out respectively.

4. Results

4.1. Primary outcome measures

The Chi-square test results revealed a statistically significant association of $p<0.03$ for the relationship of KTW vs GB and GB vs RD and $p<0.001$ for KTW vs RD inferring that any change in one parameter influenced the other.

Out of 45 recession defects, there were 46.67% sites with <2mm KTW and 53.3% >2mm KTW; 46.67% thin GB and 53.3% thick GB: 53.3% deeper RD and 46.67% shallow RD. (Figure 3, Table 1)

Among the sites with <2mm KTW, 80.95% (17) had thin GB and 19.05% (4) thick GB; 90.4% (19) deeper RD and 9.3% (2) shallow RD. The sites with >2mm KTW had 20.8% (5) thin GB and 79.17% (19) thick GB; 12.5% (3) deeper RD and 87.5% (21) shallow RD.

Among the sites with thin GB, 80.9% (17) had <2mm KTW and 19.04% (4) >2mm KTW; 90.4% (19) deeper RD and 9.5% (2) shallow RD. The sites with thick GB had 16.6% (4) <2mm KTW and 83.3% (20) >2mm KTW; 8.3% (2) deeper RD and 91.6% (22) shallow RD.

Among the sites with deeper RD, 91.7% (22) had <2mm KTW and 8.3% (2) >2mm KTW; 87.5% (21) thin GB and 12.5% (3) thick GB and sites with shallow RD had 9.52% (2) <2mm KTW and 90.48% (19) >2mm KTW; 9.52% (2) thin GB and 90.48 (19) thick GB (Table 1)

To test the correlation between KTW and GB, GB and RD and KTW and RD, Pearson correlation test was used. There was a positive correlation between KTW and GB, negative correlation between GB and RD, KTW and RD with a correlation coefficient of .320, -.046, -.136 respectively. (Figure 3, Graph 1)

The influence of KTW and GB (independent variables) on RD (the dependent variable) was analysed using an ANOVA; the results showed a F value of 1.561 and a p-value of 0.041 (the data are not presented as a table). The fact that the within-group mean square values were lower than the between-group mean square values, resulted in a larger F value suggesting that statistical significance is real and not by choice. As a result, any change in KTW and GB significantly influenced RD.

All of the aforementioned statistical analyses show that sites with <2mm KTW coexist with thin GB and deeper RD, which is referred to in the article as a negative ternion, while sites with >2mm KTW coexist with thick GB and shallow RD, which is referred to as a positive ternion.

4.2. Secondary outcome measure

Analysis of % RC revealed that there was 43.8% mean RC in sites with <2mm KTW, thin GB and deeper RD and 94.7% mean RC in sites with >2mm KTW, thick GB and shallow RD. %RC of individual parameters were as follows: 40.4% for <2mm KTW and 97% for >2mm KTW; 49.2% for thin GB and 91.3% for thick GB; 41.9% for deeper RD

and 95.8% for shallow RD. (Table 2)

5. Discussion

In this retrospective analysis of gingival recession management with CAF, we sought to investigate the triumvirate association between KTW, GB and RD on root coverage outcome.

Decades of research work has concluded that there is no definitive threshold amount of KTW that is required around natural dentition in the presence of optimal plaque control.[17,18] Nevertheless, KTW ≥2 mm appears to be essential for preventing progressive attachment loss in the presence of an inadequate plaque control.[3] The latter statement could be one of the reasons for lower %RC in sites with inadequate KTW observed in our study where some of the participants were not able to exhibit meticulous oral hygiene measures (data not reported in this paper). Final position of flap margin after coronal advancement is one of the determinants of the outcomes of RC.[2] Inadequate KTW limits post-surgical position of the margin as there is insufficient KT to begin with which is in line with the results of this study as the sites with <2mm KTW resulted in 40.4% RC whereas with sites with >2mm KTW had 97% RC.

In our study, 46.67% of defects exhibited thin GB and 53.3% sites with thick GB. Researchers have studied gingival thickness and suggested their recommendations; GT <1mm is associated with a diminished probability of complete root coverage when advanced flap designs are attempted; 1.1mm GT was reported to be a critical requirement for achieving predictable root coverage; GT >1.4mm indicated stability of marginal tissue post-surgery.[8,19–21] *Barootchi et al.,* (2020) stated that an increased soft tissue thickness is more likely to prevent the relapse of gingival margin over time.[22] All these studies support the clinical outcome observed in our study where the sites with thin GB had less than 50% RC and thick GB had more than 91% RC.

KTW and GB, constituting the periodontal soft tissue phenotype, affirmatively play the role of risk factor as they are associated with the development and progression of mucogingival defects and also as prognostic factor determining the outcomes of root coverage procedures.[1,23,24] In our study, 80.9% (17) of the sites with thin GB reported with <2mm KTW and the baseline values of KTW and GB showed a positive correlation inferring that the sites with thin GB also exhibited inadequate KTW as reported by other researchers.[9,23]

In our study, the 46.67% (21) of the sites with thin GB at baseline had deeper RD of 90.4% (19) and exhibited a negative correlation, which is in line with earlier studies that reported greater prevalence of GR in subjects with a thin GB and negative correlation between GB and GR.[10,25] This observation indicates that subjects with a thin GB are less resistant to any inflammatory, traumatic, or surgical insult and are more prone for gingival recession than the sites with thick GB.[1,26]

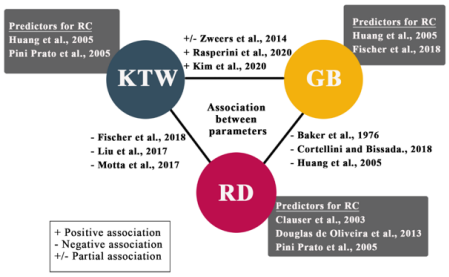


Fig. 1: Studies reporting the association of clinical characteristics. Keratinized tissue width (KTW), gingival biotype (GB), Recession depth (RD)

Fig. 2: Assessment of clinical parameters. a) and d) Pre-operative clinical pictures, b) and c)Assessment of thick GB and adequate zone of KTW, e) and f) Assessment of thin GB and inadequate zone of KTW, g) Locating MGJ, h) assessment of RD; GB-Gingival Biotype, KTW – Keratinized Tissue Width, MGJ – Mucogingival Junction,RD – Recession Depth

Deeper gingival recessions invade keratinized gingiva creating a minimal or no KTW, which in turn constrains a tension-free coronal advancement of the flap and hence the lower reduction of marginal tissue recession can be observed in coronally advanced flaps approximated with tension.[2,6] In our study, the sites with deeper RD and inadequate KTW showed lesser % RC when compared to the sites with adequate KTW and shallow RD. Our results are further supported by a histologic study which showed that the keratinized epithelium of the gingival unit tends to migrate apically with the increasing recession depth, whereas the position of the MGJ and the alveolar mucosa tend to remain unaltered.[27] These findings confirm that with the increase of the RD, the KTW tends to decrease, which leads to the partial or complete loss of the attached gingiva.

The association between initial RD and RC is debatable with fewer studies reporting greater reduction of RD in deep recession defects.[7,28] In our study, the sites with deeper RD

Table 1: Clinical measurements at baseline

		Keratinized tissue width		Gingival biotype		Recession depth	
Keratinized Tissue Width (45)	**<2mm**	**<2mm**	**>2mm**	**Thin GB**	**Thick GB**	**Deep RD**	**Shallow RD**
	21 (46.67%)	21 (100%)	-	17 (80.95%)	4 (19.05%)	19 (90.4%)	2 (9.3%)
	>2mm	**<2mm**	**>2mm**	**Thin GB**	**Thick GB**	**Deep RD**	**Shallow RD**
	24 (53.3%)	-	24 (100%)	5 (20.8%)	19 (79.17%)	3 (12.5%)	21 (87.5%)
Gingival Biotype (45)	**Thin GB**	**<2mm**	**>2mm**	**Thin GB**	**Thick GB**	**Deep RD**	Shallow RD
	21 (46.67%)	17 (80.9%)	4 (19.04%)	21 (100%)	-	19 (90.4%)	2 (9.5%)
	Thick GB	**<2mm**	**>2mm**	**Thin GB**	**Thick GB**	**Deep RD**	**Shallow RD**
	24 (53.3%)	4 (16.6%)	20 (83.3%)	-	24 (100%)	2 (8.3%)	22 (91.6%)
	Deep RD	**<2mm**	**>2mm**	**Thin GB**	**Thick GB**	**Deep RD**	**Shallow RD**
Recession Depth (45)	24 (53.3%)	22 (91.7%)	2 (8.3%)	21 (87.5%)	3 (12.5%)	24 (100%)	-
	Shallow RD	**<2mm**	**>2mm**	**Thin GB**	**Thick GB**	**Deep RD**	**Shallow RD**
	21 (46.67%)	2 (9.52%)	19 (90.48%)	2 (9.52%)	19 (90.48%)	-	21 (100%)

Table 2: Percentage RC (% RC) of individual parameters: sites with <2mm KTW, thin GB and deeper RD have 43.8% RC whereas the sites with >2mm KTW, thick GB and shallow RD have 94.7% RC.

	Keratinized tissue width		Gingival biotype		Recession depth	
% RC	**<2mm**	**>2mm**	**Thin**	**Thick**	**Deep**	**Shallow**
	40.4	97	49.2	91.3	41.9	95.8

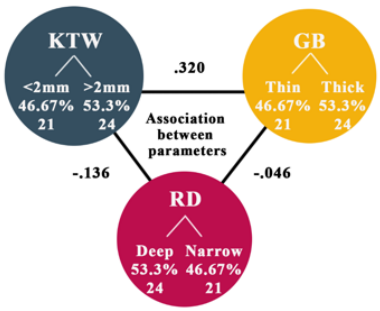
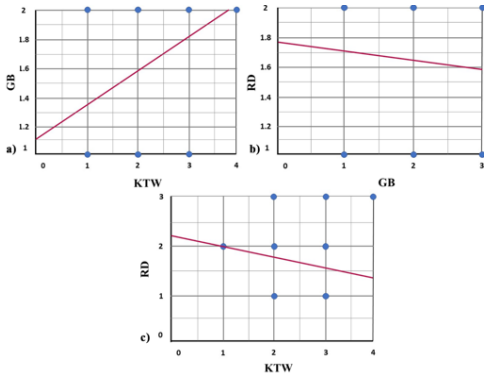


Fig. 3: Distribution of 45 defects based on each parameter. i) Correlation between the parameters:KTW and GB (r = .320), GB and RD (r= -.046), KTW and RD (r=-.136) r value = -1to +1 (-1 = negative correlation, 0 = no correlation, +1 = positive correlation). ii) Negative ternion: <2mm KTW, Thin GB, Deep RD; Positive ternion: >2mm KTW, Thick GB, Shallow RD



Graph 1: Correlation between **a)** KTW and GB (r = .320) **b)** GB and RD (r= -.046), **c)** KTW and RD (r=-.136). The sign of the coefficient indicates the direction of the relationship. If both variables tend to increase or decrease together, the coefficient is positive, and the line that represents the correlation slopes upward **(a)**. If one variable tends to increase as the other decreases, the coefficient is negative, and the line that represents the correlation slopes downward **(b & c)**.

showed 41.9% RC compared to sites with shallow RD that showed 95.8% RC and is in concordance with studies that reported lesser % RC in sites with greater RD.[6,29]

Our study analysed the correlation of KTW, GB and RD and attempted to establish a ternion of these three parameters. It has been established in our study that the phenotype of independent parameters KTW and GB significantly influenced the dependent variable RD at baseline. Among the 45 recession defects that were treated with CAF, 21 defects exhibited negative ternion (inadequate KTW, thin GB and deeper RD) and 24 defects exhibited positive ternion (adequate KTW, thick GB and shallow RD). The defects exhibiting negative ternion reported 43.8% mean RC and the defects exhibiting positive ternion reported 94.7% mean RC (Figure 3). This proves our hypothesis that there is a definitive association between KTW, GB and RD and a ternion of these parameters distinctively influences the outcome of root coverage procedures.

5.1. Limitations

The present retrospective study needs to be perceived with its limitations. The sample size was small and patients were

followed only for a short-term of 6 months.

6. Conclusion

In conclusion, KTW, GB and RD have a definite influence on the root coverage outcome and decision tree based on the ternion of these parameters will help determine the tangible outcomes of root coverage procedure.

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This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

8. Conflict of Interest

None.

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