Dentogingival Complex: Dimension Based on Biotypes

Karol Ramírez DDS, MSc*†; Omar García-Rodríguez, MS, DrPh†;
Margarita Murillo-Arocho, DDS†; Ottón Fernández-López, DDS, MSD*;
Augusto R. Elías-Boneta, DMD, MSD†

Objective: Estimate the DGC dimensions and determine whether the DGC dimension varies by gingival biotype.

Methods: A cross-sectional study was performed in the Undergraduate and Prosthodontic Graduate Program clinics of the School of Dental Medicine, University of Puerto Rico from August 2011 to April 2012. A total of 53 participants who needed restorative crowns in their teeth were recruited. Prior to crown preparation, the gingiva was classified as having a thin, mixed or thick biotype, according to transparency, using a standardized 15 UNC Hu-Friedy® periodontal probe. The DGC dimension was measured by transulcus probing. Descriptive statistics were calculated in mesial, medial, and distal sites by phenotypes. Differences between and within the sites' DGC dimension mean were determined using a Friedman test. The level of significance was 0.05.

Results: Mean DGC dimensions, in millimeters, for all sites measured were: 3.09 (95% CI: 2.91-3.27), 3.40 (95% CI: 3.18-3.62), 2.70 (95% CI: 2.51-2.89), and 3.17 (95% CI: 2.94-3.41) in mesial, medial, and distal sites, respectively. In thick, mixed, and thin biotypes the mesial sites showed greater DGC dimension means than the medial and distal ($p<0.05$) sites. Mean DGC dimension was greater for the thin compared to mixed and thick biotypes at mesial, medial and distal sites ($p<0.001$). Nevertheless, the thick biotype presented the smallest DGC mean dimensions compared to mixed and thin biotypes at the same sites.

Conclusion: The DGC dimensions in all sites were similar to those reported in the literature. DGC dimensions are different for thin, mixed and thick gingival biotypes.
[*P R Health Sci J 2013;4:182-186*]

Key words: Dentogingival complex dimension, Gingival biotype

A dental crown (crown) is a metallic, porcelain or porcelain fused to a metal cover or jacket that fits a tooth prepared by a dentist (1, 2). It is the restorative treatment of choice when teeth have been extensively destroyed due to caries, fracture, and/or pathologic wear (3). Crowns are designed to withstand biting forces, restore masticatory function, improve aesthetics, and facilitate phonetics (4). Incorrect crown margin placement, invading the Dentogingival Complex (DGC) attachment zone, increases the risk of inflammation, spontaneous bleeding, hyperplasia, and gingival recession (5, 6), predisposing host susceptibility to gingival and periodontal diseases (7). Gingival inflammation and periodontal diseases may be contributing factors that aggravate systemic conditions (8). Therefore, a well-established guide for crown margin placement is important to avoid adverse health effects and maintain aesthetics.

The DGC dimension is the sum of the combined widths of the connective tissue fibrous attachment, the functional epithelium, and the sulcus adjacent to the tooth (Figure 1) (9). Its function is to provide the tooth with a natural barrier of protection from mechanical trauma and bacterial infection (8).

Probing to the alveolar bone crest (bone sounding) for measuring the DGC dimension is a reliable method and a highly dependable tool in determining the bone crest level (9, 10-12).

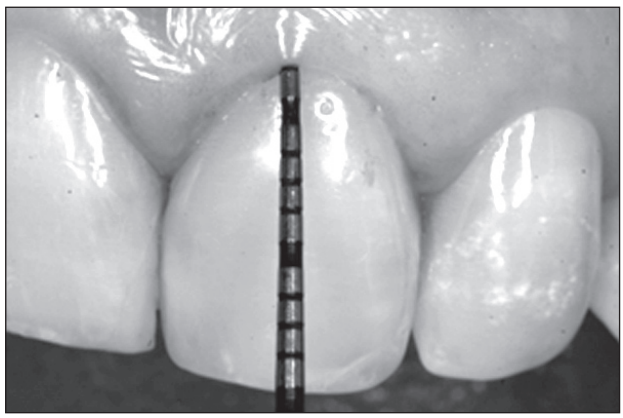

Figure 1. DGC dimension for each site was taken by transulcus probing at three sites (mid-facial, mesial-facial and distal-facial); the distance measured was from the free gingival margin to the osseous crest.

*School of Dentistry, University of Costa Rica, Costa Rica; †School of Dental Medicine, University of Puerto Rico Medical Sciences Campus, San Juan, Puerto Rico

The authors have no conflict of interest to disclose.

Address correspondence to: Augusto R. Elias-Boneta, Assistant Dean of Research, University of Puerto Rico Medical Sciences Campus, PO Box 365067, San Juan, PR 00936-5067. Email: augusto.elias@upr.edu

The major concern when bone sounding is rupture of epithelial and fibrous connective tissue attachment, and possible apical migration of the gingival attachment (13); however, rupture of the connective tissue attachment in healthy gingival tissue is reversible (14).

A limited number of studies in the scientific literature report mean values of DGC dimensions. Gargiulio and his co-workers (15) reported a mean DGC dimension of 2.73 mm for anterior and posterior teeth in an ex-vivo study. Vacek et al. (16) published a mean DGC dimension of 3.65 mm, using molars from the mandibular jaw of cadavers. In a clinical study measuring 100 maxillary central incisors, the DGC dimension reported for the incisors' mid-facial aspect was 3 mm and 3 to 4.5 mm in the inter-proximal tooth aspect (9). Perez and his coworkers (11), reported a range of 2 to 5 mm, and 3 mm to 5 mm for mid-facial and mesial-interproximal tooth aspects, respectively. In addition, several authors have described a relationship between mean DGC position and osseous high crests. The DGC means for normal crest were 3 mm at mid-facial sites and 4 mm inter-proximally. When adjacent teeth were present, DGC mean dimensions for high crests measured ≤ 3 mm facially, and 4 mm inter-proximally. Low crest patients have a DGC dimension >3 mm facially, and 4 mm inter-proximally (8).

Several authors have suggested that the DGC dimension differs according to gingival biotypes, described as thin, thick and mixed (17, 18). Patients with a thin gingival biotype (thickness is <1.5 mm) have a higher risk of gingival or periodontal disease compared to thick (thickness is > 2 mm) gingival biotype (19). Similarly, a thick-flat tissue biotype was an important factor for successful esthetic implant restorations (20). Thin gingival tissue tends to be fragile and almost translucent in appearance; when porcelain fused to metal restorations are placed subgingivally, a grayish translucency can be seen through the gingiva. Delicate management is essential for thin biotypes to avoid gingival recession and visibility of subgingival margins. However, thick periodontal biotypes are fibrotic and resilient, making them more resistant to gingival recession. Crowns margins can be placed subgingivally in aesthetics zones in subjects with a thick biotype (21, 22). The stability of the osseous crest and soft tissue is directly proportional to the thickness of the bone and gingival biotype. Long-term gingival tissue health and esthetics of restorative crowns have been related to gingival biotypes and integrity of connective tissue fibers in the DGC. Therefore, understanding the structure and physiology of the gingival biotype is necessary for achieving a healthy gingiva (1).

There seems to be a lack of scientific literature focusing on the relationship between DGC dimensions and gingival biotypes. Therefore, the aims of this study were to estimate the DGC dimensions and determine whether the DGC dimensions vary by gingival biotype.

Methods

A cross-sectional study was performed at the undergraduate and post-doctoral Prosthodontics clinics of the School of Dental Medicine of the University of Puerto Rico (UPR) from August 2011 to April 2012. This protocol was approved by the UPR, Medical Sciences Campus Institutional Review Board (IRB).

Study group and sampling design

A convenience sample of 53 subjects was selected from patients seeking treatment at the Undergraduate and Prosthodontics Postdoctoral Program Clinics. Seventeen patients were needed in each biotype group to detect a difference of 0.4 mm among the DGC dimension means with a 0.4 mm standard deviation, using 80.0% power and 0.05 significance level (23).

The Principal Investigator visited the dental clinics on a daily basis and identified potential participants. Eligible patients were invited and fully informed of this investigation. Those who consented to participate signed a written informed consent.

Inclusion criteria

Patients were eligible for this study if:

- They were 21 years of age or older, at the time of enrollment
- Were mentally competent to consent
- Placement of a restorative crown on any of their maxillary or mandibular premolar, canine, or incisive teeth was indicated.

Exclusion criteria

Patients were excluded if:

- periodontal disease was present
- a crown lengthening procedure was indicated
- they had undergone active orthodontic therapy at the tooth to be measured or adjacent teeth
- had complications due to local anesthesia
- had uncontrolled diabetes mellitus
- had connective tissue disorders
- were infected with human immune deficiency virus
- antibiotic prophylaxis was needed before dental procedures
- there was presence of bleeding disorders or were currently on active anticoagulant therapy
- were undergoing active cancer and treatment
- taking phenytoin or cyclosporine

Training and standardization

Prior to the study, a reference examiner underwent a training and standardization exercise on DGC measurements and biotype classification at the Prosthodontics Postgraduate Program, University of Costa Rica. An acceptable value of inter-examiner percent agreement of 62.0% for site level measurements within +/- 1mm was obtained.

Procedures

Prior to crown preparation, the restorative dentist applied local anesthesia in the medial mucosa of the tooth to be prepared. The selected tooth's gingiva was classified as having a thin, mixed, or thick periodontal biotype according to the transparency using a standardized 15 UNC Hu-Friedy® periodontal on the gingival margin (9). The biotype was categorized as:

1) thin-if the outline of the underlying probe could be seen through the gingiva,
2) thick-if the probe could not be seen,
3) mixed-if the probe could be seen, but not clearly.

The DGC dimension was measured by transulcus probing (8, 9, 12) at the mesial, medial and distal tooth surfaces measured from the free gingival margin to the osseous crest (Figure 1). Interproximally, the probe was positioned parallel to the dental root until it touched the contact area. The periodontal probe's tip had to reach the bone crest at its junction with the tooth. In the medial sites, the periodontal probe was kept parallel to the long axis of the tooth. The DGC dimensions of the patients were measured on one of their maxillary or mandibular premolar, canine, or incisive teeth.

Statistical analysis

Central tendency measurements (mean, and its 95% confidence intervals, and median), and dispersion measurements (standard deviation, and minimum and maximum) for the DGC dimension were calculated for the mesial, medial and distal sites.

DGC dimension measurements at each site, as well as their average, were not normally distributed as demonstrated by the Shapiro-Wilk normality test; therefore, non-parametric tests were used to detect differences by phenotype and measurement site (24).

A Friedman test was used to evaluate statistically significant differences between biotype and by site. Multiple comparisons means Scheffé test were performed to determine differences among mesial, medial, and distal sites by phenotype (9). The level of significance was 0.05. Statistical Analysis System (SAS) software was used for all the statistical tests (version 9.1, Cary, NC).

Results

A total of 53 patients, 23 male and 30 female, were examined. The age range was 21 to 70 years. One tooth per participant was examined: twelve central incisors, fifteen lateral incisors, twelve canine, and fourteen premolars. The biotypes of fifty-two teeth were categorized: seventeen teeth as thick, seventeen teeth as mixed, and eighteen as thin.

As described in Table 1, the site average for all teeth examined was 3.10 mm (95% CI: 2.92-3.28 mm). The DGC dimension means at mesial sites (3.41 mm; 95% CI: 3.18-3.63 mm) were higher than medial (2.7 mm: 95% CI: 2.52- 2.90 mm) and distal (3.1 mm; 95% CI: 2.95-3.41 mm) sites.

Table 1. Summary Statistics (mm) and 95%CI mean of overall DGC dimensions by sites (n=53)

Site	Mean	SD	IC 95% Mean	Median	Min.	Max.
Mesial 5.00	3.40	0.80	3.18, 3.62		3.50	2.00
Medial	2.70	0.69	2.52, 2.90	3.00	1.00	4.00
Distal	3.17	0.84	2.95, 3.41	3.00	2.00	6.00
Site Average	3.09	0.65	2.92, 3.28	3.00	1.66	4.33

Min. = minimum; Max. = maximum

As stated in Table 2, for thick, mixed, and thin biotypes the mesial sites showed greater DGC dimension means than medial and distal sites. Table 3 presents differences when comparing the mean DGC dimensions in the three different gingival biotypes by site ($p<0.05$). Thin biotypes of mesial, medial, and distal sites showed the greatest DCG mean dimensions compared to mixed and thick biotypes at the same sites. Nevertheless, the thick biotype presented the smallest DGC mean dimensions compared to mixed and thin biotypes at the same sites ($p\leq0.0001$).

Table 2. Descriptive Statistics (mm) and mean 95% CI of DGC dimensions by biotypes and sites

Biotype	Site	Mean	SD	95% CI Mean	Median	Min.	Max.
Thick (n=17)	Mesial	2.79	0.66	2.45-3.13	3.00	2.00	4.00
	Medial	2.20	0.50	1.95-2.46	2.00	1.00	3.00
	Distal	2.61	0.78	2.22-3.02	2.50	2.00	5.00
	Site Average	2.53	0.54	2.26-2.82	2.50	1.66	4.00
Mixed (n=18)	Mesial	3.22	0.39	3.03-3.41	3.00	3.00	4.00
	Medial	2.66	0.48	2.43-2.91	3.00	2.00	3.00
	Distal	3.16	0.42	2.96-3.39	3.00	3.00	4.50
	Site Average	3.01	0.20	2.92-3.12	3.00	2.66	3.50
Thin (n=18)	Mesial	4.16	0.64	3.85-4.49	4.00	3.00	5.00
	Medial	3.22	0.69	2.88-3.57	3.00	2.00	4.00
	Distal	3.72	0.89	3.27-4.17	4.00	2.00	6.00
	Site Average	3.70	0.52	3.44-3.97	3.91	2.83	4.33

Min. = minimum; Max. = maximum

Table 3. DGC mean dimensions comparing among biotype sites

Thick/Mesial (mm) (n=17)	Mixed/ Mesial (mm) (n=18)	Thin/Mesial (mm) (n=18)	p-value*
2.79±0.151	3.22±0.09	4.16±0.16	<0.0001
Thick/Medial	Mixed/Medial	Thin/Medial	
2.20±0.16	2.66±0.11	3.22±0.16	<0.0001
Thick/Distal	Mixed/Distal	Thin/Distal	
2.61±0.18	3.16 ± 0.10	3.72±0.21	0.006
Thick/Average	Mixed/Average	Thin/Average	
2.53±0.13	3.01±0.04	3.70±0.12	<0.0001

*p-value using Friedman test to determine between differences of sites

Table 4 shows the comparisons in the DGC by biotype. When compared to the thick biotype, mesial sites had greater DCGs than medial sites (p=0.042); similarly, in thin biotypes, mesial sites were also greater when compared to medial sites (p=0.0006). Furthermore, in mixed biotypes, mesial sites were greater than both medial sites (p=0.0020) and distal sites (p=0.005).

Table 4. DGC mean dimensions pair comparing by biotype and sites

Biotype	Site	(mm)	Mesial (mm)	Medial (mm)	Distal (mm)	p-value*
Thick	Mesial	2.79±0.092		2.20±0.114		0.042**
	Medial	2.20±0.114			2.61±0.099	0.201
	Distal	2.61±0.099	2.79±0.092			0.738
Mixed	Mesial	3.22±0.161		2.66±0.122		0.002**
	Medial	2.66±0.122			3.16±0.189	0.005**
	Distal	3.16±0.189	3.22±0.161			0.929
Thin	Mesial	4.16±0.151		3.22±0.163		0.002**
	Medial	3.22±0.163			3.72±0.211	0.146
	Distal	3.72±0.211	4.16±0.151			0.216

*p-value using multiple comparison means Scheffé test to determine within differences of sites.
** Statistical significantly difference

Discussion

The aims of this study were to estimate the DGC dimensions and determine whether the DGC dimension varies by gingival biotype. The site average mean for all teeth examined was 3.09 mm. Gargiulo et al. (15), in 1961, reported an overall mean DGC dimension of 2.73 mm. In this study, the DGC dimension was assessed using an ex-vivo group; these differences may be attributed to the method employed to measure DGC dimension. Additionally, our measurements were made with a periodontal probe indicating one millimeter measurement increments vs. a micrometer used by Gargiulo. The mean values reported by Gargiulo corresponded to anterior teeth, premolars and molars, but in the present study only anterior teeth and premolars were measured.

Kois (7) reported the mean DGC dimension for the mid-facial sites as 3 mm and 3 mm to 4.5 mm for the interproximal sites, respectively. In this study, we found that the overall mid-facial site ranged from 1 to 4 mm and an overall interproximal site ranging from 2 mm to 6 mm. Our findings suggest differences exist between and within teeth, biotype, and patients.

Crest classification measurements of the DGC (11, 25, 26) at mid-facial sites are similar with our average site means, based on gingival biotypes. In our study, thick biotypes had a site average of less than 3 mm (2.53 mm), mixed biotypes had a site average of 3.01 mm, and thin biotypes had a site average of more than 3 mm (3.70 mm). Furthermore, we observed that DGC dimensions tended to increase from thick biotypes to mixed and thin. These results suggest that determining the DGC dimension individually provides a more accurate measurement rather than using a standard measurement (linear figure of 3 mm) for all patients. Statistically significant differences were observed between biotypes in the DGC dimension. The mean measurements obtained for each biotype may be used as a reference clinically by adding to the mean value 0.5 mm; i.e., thick biotype 2.50 mm, mixed biotype 3.00 mm, and thin biotype, 4.00 mm.

Determining the DGC dimension by gingival biotype on an individual patient-to-patient basis, will certainly aid dentists in the treatment planning and execution of a number of dental procedures including crown margin placement. A better understanding of these biological variables allows a better clinical approach that results in a higher level of predictability and periodontal homeostasis, leading to periodontal health in prosthetic and/or periodontal surgical procedures.

The small sample size in the present study is considered a limitation because results cannot be generalized to the general population.

Conclusion

The resulting DGC dimensions in all sites in this study were similar to those reported previously in the literature. There were differences among the means of the DGC dimensions between gingival biotypes and sites. Thick periodontal biotype DGC dimensions were greater than that of mixed and thin biotypes. Future studies should increase the sample size, and evaluate the relationship between the lengths of the crest and the gingival biotype.

Acknowledgments

The authors would like to thank Dr. Sona Rivas-Tumanyan, for statistical analysis; Dr. Arturo Blanco for study design advice; Dr. David Malaret and Dr. Claudia Ancira for support recruiting participants. "This publication was possible by grants from the National Center for Research Resources (U54 RR 026139-01A1) and the National Institute on Minority Health and Health Disparities (8U54 MD 007587-03) from the National Institutes of Health."

References

1. Kelly R, Nishimura I, Campbell, S. Ceramics in dentistry: Historical roots and current perspectives. J Prosthetic Dent 1996;75:18-31.
2. Jedynakiewicz NM. Encyclopedia of Biomaterials and Biomedical Engineering. Ceramics in Dentistry 2006;1-11.
3. O¨rtorp A, Kihl ML, Carlsson GE. A 3-year retrospective and clinical follow-up study of zirconia single crowns performed in a private practice. J Dent 2009;3:773-736.

4. Burns DR, Beck DA, Nelson SK. A review of selected dental literature on contemporary provisional fixed prosthodontic treatment: Report of the Committee on Research in Fixed Prosthodontics of the Academy of fixed Prosthodontics. J Prosthetic Dent 2003;90:474-497.
5. Khuller N, Sharma N. Biologic Width: Evaluation and Correction of its Violation. J Oral Health Comm Dent 2009;3:20-25.
6. Xiaojing Li, Kristin M. Kolltveit, Leif Tronstad, Ingar Olsen. Systemic diseases caused by oral infection. Clin Microbiol Rev 2000;13:547-558.
7. Kois JC. The restorative-periodontal interface: biological parameters. Periodontology 2000 1996;11:29-38.
8. Padbury A, Eber R, Wang HL. Interactions between the gingival and the margin of restorations. J Clin Periodontol 2003;30:379-385.
9. Jorgić-Srdjak K, Plančak D, Maričević T, Dragoo MR, Brošnjak A. Periodontal and Prosthetic Aspect of Biological Width Part I: Violation of Biologic Width. Acta Stomatol Croat 2000;34:195-197.
10. Irfan A. Protocols for predictable aesthetic dental restorations [serial online]. Oxford: Blackwell Munksgaard; 2006. Available from: Url: http://thiqaruni.org/medcine/117.pdf . Accesed May 26, 2012.
11. Kois JC. Altering gingival levels: the restorative connection part I: biologic variables. J Esthet Dent 1994;6:3-9.
12. Perez JR, Smukler H, Nunn ME. Clinical evaluation of the suppraosseous gingivae before and after crown lengthening. J Periodontol 2007;78: 1023-1030.
13. Hornbrook D. Clinically Speaking Perio-restorative harmony. Dental Practice Report 2005:36-42.E
14. Ahmad I. Anterior dental aesthetics: Gingival perspective. British Dental Journal 2005:199;195-202.
15. Garguilo AW, Wentz FM, Orban B. Dimensions and relations of the dentogingival junction in humans. J Periodontol 1961;32:321.
16. Vacek JS, Gher ME, Assad DA, Richardson AC, Giambarresi LI. The dimensions of the human dentogingival junction. Int J Periodontics Restorative Dent 1994;14:154-65.
17. Kan JYK, Rungcharassaeng K, Umezu K, Kois J. Dimensions of peri-implant mucosa: An evaluation of maxillary anterior single implants in humans. J Periodontol 2003;74:557-562.
18. Sanavi F, Weisgold AS, Rose L F. Biologic width and its relation to periodontal biotypes. J Esthet Dent 1998;10:157-163.
19. Kois JC. Predictable single tooth peri-implant esthetics: Five diagnostic keys. Compend Contin Educ Dent 1996:199-206;quiz 208.
20. Lee A, Fu JH, Wang HL. Soft Tissue Biotype Affects Implant Success. Implant Dent 2011;20:e38-47.
21. Nagaraj, KR, Savadi, RC, Savadi, AR, Prashanth Reddy, GT, Srilakshmi, J, Dayalan M, John, J. Gingival Biotype - Prosthodontic Perspective. J Indian Prosthodont Soc 2010;10:27-30.
22. Sanavi F, Weisgold AS, Rose LF. Biologic width and its relation to periodontal biotypes. J Esthet Dent 1998; 10: 157-163.
23. Dupont WD, Plummer WD. Power and Sample Size Calculations: A Review and Computer Program. Control Clin Trials 1990;11:116-28.
24. Rosner, Bernard. Fundamentals of Biostatistics. Belmont, CA: Thomson-Brooks/Cole, 2006. Print.
25. Coslet GJ, Vanarsdall R, Weisgold A. Diagnosis and classification of delayed passive eruption of the dentogingival junction in the adult. Alpha Omegan 1997;10:24-28.
26. Robbins JW. Tissue management in restorative dentistry. Funct Esthet Restor Dent 2007;1:40-43.