

Influence of anatomic reference on the buccal contour of prosthetic crowns

Flávia Sabrina Queirós Vasconcelos^(a)
Ana Christina Claro Neves^(b)
Laís Regiane da Silva-Concílio^(b)
Leonardo Gonçalves Cunha^(b)
Sigmar de Mello Rode^(c)

^(a)MSc, Graduate Student; ^(b)PhD, Professor;
^(c)PhD, Full Professor – Graduate Program in Prosthodontics, Dentistry Course, University of Taubaté, Taubaté, SP, Brazil.

Abstract: During clinical practice, when performing prosthetic rehabilitation with single crowns, improper reproduction of the dental contour by the dental laboratory is a common occurrence. Therefore, the present study evaluated the fidelity of the reproduction of the buccal contour in an upper left canine performed by three Dental Prosthesis Technicians (DPT) using the indirect laminate veneer technique. First, the DPTs confected the veneers based on a model obtained from the upper arch of a dental dummy, containing a replica of an upper left canine with a prosthetic preparation for a laminate veneer. Then, the same DPTs received other identical models, now with the replica of the upper left canine with no preparation, to be used as an anatomical reference for confecting the laminate veneers. The laminate veneers were then bonded to the plaster models and had their buccal contour individually measured. Measurements were also made of the buccal contour of the reference canine. The data were analyzed by ANOVA and the t-test ($p = 0.05$). Results showed 100% of buccal overcontour when the laminate veneers were compared to the reference canine, regardless of which DPT confected the veneer and regardless of using or not the anatomical reference. The DPTs who participated in the present study were unable to accomplish a faithful anatomical reproduction of the buccal contour, creating an overcontour in all samples. This situation may be responsible for increasing the probability of periodontal and esthetic harm in clinical practice.

Descriptors: Dental restoration failure; Dental crowns; Dental prosthesis.

Corresponding author:

Laís Regiane da Silva-Concílio
Rua Expedicionário Ernesto Pereira, 110
Taubaté - SP - Brazil
CEP: 12020-330
E-mail: regiane1@yahoo.com

Received for publication on Sep 25, 2008
Accepted for publication on May 28, 2009

Introduction

Correct reconstruction of the dental anatomy is one of the main objectives of dental restorative treatment. Restoring the form and function of the tooth allows proper functioning of the temporomandibular joint structures, resulting in health and improving the quality of life of the patient. It additionally facilitates mastication and oral hygiene, preserving periodontal physiology and propitiating clinical longevity of the restoration.¹⁻⁵

Inadequate reproduction of the dental contour is frequently associated with esthetic drawbacks, in addition to periodontal damage.^{3,4} The periodontal tissue is frequently colonized by agents associated with periodontal pathologies. Therefore, a correct contour of the restoration is essential for periodontal health.^{6,7}

Preservation of periodontal health depends, among other factors, on the dental preparation, which must create enough space for the restorative material,^{4,8} thus preventing overcontour of the restoration. A prosthetic element with overcontour can cause gingival inflammation, increasing the degree of severity of periodontal illness and promoting loss of supporting bone in the adjacent regions of the surfaces with excess material.⁸

Natural teeth, with rare exceptions caused by individual variation,⁹ present rectilinear contour in the gingival margin and an arched coronary contour from the cemento-enamel line towards the occlusal aspect.⁹ Aiming at preserving the natural contour of the tooth during reproduction, there are some factors that cannot be neglected by the dentist or by the dental prosthetic technician (DPT), such as a standard confection of the prosthetic crown.¹⁰⁻¹⁴ A previous study observed the importance of using the homologous natural tooth as a guide for the confection of the contour of crowns, thus producing a restoration with a morphology similar to that of the natural tooth being reproduced.^{12,15-18}

Therefore, the aim of the present study was to compare the buccal contour of laminate veneers confectioned by DPTs during the laboratorial step of prosthodontic rehabilitation, using or not a reference tooth for guidance. The tested hypothesis was that use of the reference tooth provides a significant

improvement of the buccal contour of the laminate veneers confectioned by the DPTs.

Material and Methods

Obtaining the replica and performing the preparation

For the present study, an artificial tooth corresponding to the upper left canine was selected from a dental dummy (Dental Sem Limites, São Paulo, SP, Brazil). The tooth was removed from the dummy and a first impression was taken using a polyvinyl siloxane impression material (Adsil, Vigodent, Petrópolis, RJ, Brazil). This preliminary impression was filled using dental stone type IV (Herostone, Vigodent, Petrópolis, RJ, Brazil) to obtain a replica of the artificial canine (control).

After that, a laminate veneer preparation was performed on the replica⁹ with a depth of 1.0 mm using a bur especially designed for laminate preparations (FG2309, Swiss Dental Products, Grancia, Switzerland). A chamfer was created on the cervical portion of the tooth using a diamond bur (FG2135, Swiss Dental Products, Grancia, Switzerland) and its limit was standardized at the gingival margin, simulating a clinical condition of no invasion of the biological space. The prepared replica was positioned on the dental dummy in the upper left canine position. After that, impressions using a stock tray (Vernes S3, Tecnodent Ind. Com. Ltda., São Paulo, Brazil) and polyvinyl siloxane (Adsil, Vigodent, Petrópolis, RJ, Brazil) of the total upper dental arch were taken. From these impressions, 24 total plaster models with the prepared replica were obtained using dental stone type IV (Herostone, Vigodent, Petrópolis, Brazil).

Three dental prosthesis technicians (DPT) were selected to confection the laminate veneers. All of them had the same educational degrees and time of professional experience. The veneers were performed in two different conditions, as follows:

- **Using no reference:** In the no reference condition, each DPT received just the four models with the prepared replica, with no guidance as to how confection the laminate veneer.
- **Using a reference tooth:** In the reference condition, each one of the same professionals received

other four models, which were identical to those used in the initial condition, and an artificial upper left canine with no preparation (control), to be used as an anatomical reference for the confection of the laminate veneer.

All laminate veneers were confected with an indirect restorative composite (Artglass, Heraeus Kulzer, Hanau, Germany) and bonded to the prepared teeth using a universal cyanoacrylate base adhesive, (Loctite Henkel, Itapevi, SP, Brazil) by a single dentist. One layer of the adhesive was applied using a microbrush (Microbrush International, Grafton, WI, United States) on the inner surface of the laminate veneers and held in place with finger pressure for 30 seconds.

Measurement of the buccal contour of all samples was performed using a contact profilometer (Hyper KN810, Mitutoyo, Kawasaki, Japan). The readings were made on the laminate veneers bonded to the prepared replica and on the artificial upper left canine with no preparation (control). The samples were individually positioned in an acrylic resin (Classico, São Paulo, SP, Brazil) device, confected for the present study, consisting of a negative impression mold of the lingual aspect of the canine in order to

standardize sample position while performing readings with the profilometer. The measurements were performed vertically, using the gingival margin as a reference for the zero point. The values measured by the contact profilometer were recorded at zero, 0.5, 1.0, 1.5, and 2.0 mm from the gingival margin.

The inter- and intra-group results were statistically analyzed, first observing a normal distribution by the Kolmogorov-Smirnov test (adherence Lilliefors). After that, one-way ANOVA and the *post hoc* Student t-test ($\alpha = 0.05$) were used.

Results

The mean values (μm) of overcontour at the positions zero, 0.5, 1.0, 1.5, and 2.0 mm from the gingival margin for the unprepared artificial teeth (control) and for the laminate veneers (regardless of using or not an anatomical reference) are shown in Table 1. All laminate veneers presented statistically higher mean values of overcontour when compared to the unprepared artificial teeth, regardless of the position measured and of the DPT.

Table 2 shows the mean values of buccal contour when using or not using the reference tooth during the confection of the laminate veneers. For DPT 1,

Table 1 - Mean values (μm) of buccal contour, standard deviations (SD) and p value comparing the buccal contour of the unprepared artificial tooth (control) and the laminate veneer regardless of using or not an anatomical reference.

Position (mm)	DPT	Control	Laminate veneer		p value
			Mean	SD	
0	1	0.00	0.2285	0.1092	< 0.001*
	2		0.3499	0.1307	< 0.001*
	3		0.3594	0.1661	< 0.001*
0.5	1	0.05	0.2633	0.0813	< 0.001*
	2		0.4264	0.1040	< 0.001*
	3		0.4240	0.1965	< 0.001*
1.0	1	0.09	0.3072	0.1037	< 0.001*
	2		0.5112	0.1092	< 0.001*
	3		0.4702	0.2320	< 0.001*
1.5	1	0.14	0.3117	0.1138	< 0.001*
	2		0.5473	0.1297	< 0.001*
	3		0.4987	0.2482	< 0.001*
2.0	1	0.18	0.3204	0.1368	< 0.001*
	2		0.5620	0.1370	< 0.001*
	3		0.5243	0.2554	< 0.001*

*statistically significant at the level of 5% (Student's t-test). DPT: Dental prosthetic technician.

Table 2 - Mean values (μm) and p value comparing the buccal contour of the laminate veneers using or not a reference tooth.

Position (mm)	DPT	Laminate veneer with anatomic reference	Laminate veneer without anatomic reference	p value
0	1	0.1707	0.2863	0.053
	2	0.3687	0.3312	0.2910
	3	0.4304	0.2885	0.0794
0.5	1	0.2146	0.3121	0.0510
	2	0.4463	0.4065	0.2338
	3	0.5540	0.2941	0.0279*
1.0	1	0.2376	0.3769	0.0708
	2	0.5483	0.4742	0.1985
	3	0.6442	0.2963	0.0176*
1.5	1	0.2104	0.4130	0.0303*
	2	0.6025	0.4922	0.2150
	3	0.6873	0.3101	0.0238*
2.0	1	0.2193	0.4215	0.0473*
	2	0.6223	0.5018	0.2267
	3	0.6987	0.3499	0.0878
Mean		0.4436	0.3703	

*statistically significant at the level of 5% (Student's t-test). DPT: Dental prosthetic technician.

when the veneers were confected without the anatomical reference tooth, statistically higher mean values of overcontour were observed at positions 1.5 and 2.0 mm. For DPT 2, no difference was observed when using or not using the reference tooth, at all positions. However, for DPT 3, when the reference tooth was used, statistically higher mean values of overcontour were observed at positions 0.5, 1.0 and 1.5 mm.

Discussion

Evaluating variations in dental contour is an important aspect of dental research^{4,12} because the presence of overcontour in restorations is an iatrogenic factor that propitiates gingival inflammation^{3,4,10} and dental breaking, compromising esthetically the restored element.^{1,4}

Aiming at eliminating the possibility of overcontour by the DPT related to lack of space for the restorative material, and also at reducing the probability of fracture of the restoration, a wear to the depth of 1 mm during tooth preparation was accurately performed to create enough space for the veneer.^{12,17,19} However, overcontour occurred in all

laminate veneers confected in the present study, regardless of which DPT performed the procedure and of the use or not of an anatomical reference tooth (Table 1). Similar results were observed in previous studies, in which most of the restorations presented an increased volume when compared to the original tooth.^{10,17}

An interesting finding of the present study was that when the values of buccal contour using or not an anatomic reference were compared (Table 2), it was observed that the veneers using the reference presented higher means of overcontour. Thus, the ideal anatomical outline that was supplied for confecting the veneers seems to have been neglected. Significant differences were observed at positions 0.5, 1.0 and 1.5 mm for DPT 3, and at positions 1.5 and 2.0 mm for DPT 1. Interestingly, the values of overcontour observed for DPT 3 were higher when the anatomical reference was used (Table 2). Therefore, these results suggest that DPTs are not usually able to adequately reproduce the dental contour during a prosthetic rehabilitation. This situation may be related to a lack of knowledge about the effects of over- or undercontour on the periodontal tissue.^{3,5,10}

It may also be explained by an attempt at increasing the thickness of the veneer to improve the strength of the restoration, thus reducing the possibility of fracture of the prosthetic component.⁴

It must be pointed out that coronary contour may vary in different regions of the mouth, and also in a same tooth. Therefore, it is necessary to use the natural outline as a model during the reconstruction of the tooth contour,⁵ aiming at obtaining a satisfactory rehabilitation. Nevertheless, this situation was not observed in the present study since 100% of the veneers presented overcontour, even when a morphological reference was used during the sculpture of the laminate veneers.

Access to hygienic cleaning is a basic factor for the maintenance of periodontal health. In some cases, this is even more relevant than the restorative contour.^{20,21} A previous study concluded that a healthy periodontium supports overcontour or undercontour of up to 1.0 mm during four months.²² All of the veneers in the present study presented overcontour values below 1.00 mm. However, in order to evaluate the consequences of this level of overcontour, longitudinal clinical studies would be necessary.

Also, the method used to measure overcontour is of significant importance,^{4,12} because it has a significant influence on the compliance of the results. In

the present study, a contact profilometer was used because this device allows the standardization of the sample position at the moment of the measurement of each sample, thus increasing the confidence of the results obtained.

The hypothesis tested in the present study was not validated. Even when using a reference tooth as guidance during prosthetic confection, all the veneers presented overcontour. Thus, dentists should always supply the DPT with as much information as possible regarding the form and position of the natural tooth in the arch, so that this information can be used as guidance during the sculpture of the prosthetic restoration. The only way to modify the results observed in the present study is to establish a closer communication between dentist and DPT. Furthermore, the dentist should bear in mind that he is responsible for making a correct prosthetic preparation, thus allowing a correct indirect restoration to be made by the DPT, and also for not accepting restorations made with inadequate coronary contour.

Conclusion

Within of the limits of the present study, it could be concluded that 100% of the laminate veneers presented overcontour, regardless of the use of an anatomic reference during the sculpture of the veneers.

References

1. Kissov HK, Popova EV, Katsarov SG. Position of crown margin in relation to the tooth preparation line. *Folia Med.* 2008;50(2):57-62.
2. Davis MV. The importance of contour on full coverage restorations. *Pract Periodontics Aesthet Dent.* 1992;4(1):17-23.
3. Kohal RJ, Gerds T, Strub JR. Effect of different crown contours on periodontal health in dogs: Clinical results. *J Dent.* 2003;31(6):407-13.
4. Becker CM, Kaldahl WB. Current theories of crown contour, margin placement, and pontic design. 1981. *J Prosthet Dent.* 2005;93(2):107-15.
5. Yu H, Li Q, Hu J, Wang Y. An improved method to analyse tooth and restoration contour using image analysis: application in the maxillary anterior teeth in Chinese population. *Arch Oral Biol.* 2008;53(6):503-8.
6. Broadbent JM, Williams KB, Thomson WM, Williams SM. Dental restorations: a risk factor for periodontal attachment loss? *J Clin Periodontol.* 2006;33(11):803-10.
7. Matthews DC, Tabesh M. Detection of localized tooth-related factors that predispose to periodontal infections. *Periodontol* 2000. 2004;34(1):136-50.
8. Gilmore N, Sheiham A. Overhanging dental restorations and periodontal disease. *J Periodontol.* 1971;42(1):8-12.
9. Schillingburg HT, Hobo S, Whitsett LD, Jacobi R, Brackett SE. *Fundamentals of fixed prosthodontics.* 3rd ed. Chicago (IL): Quintessence Publishing Co.; 1997.
10. Kissov HK, Todorova BP, Popova EV. Correlation between overcontouring of fixed prosthetic constructions and accumulation of dental plaque. *Folia Med.* 2001;43(1-2):80-3.
11. Khalaf K, Elcock C, Smith RN, Brook AH. Fluctuating dental asymmetry of multiple crown variables measured by an image analysis system. *Arch Oral Biol.* 2005;50(2):249-53.
12. Alhourri N, Watts DC, McCord JF, Smith PW. Mathematical analysis of tooth and restoration contour using image analysis. *Dent Mater.* 2004;20(9):893-9.

13. Hahn P, Gustrav M, Hellwig E. An *in vitro* assessment of the strength of porcelain veneers dependent on tooth preparation. *J Oral Rehabil.* 2000;27(12):1024-9.
14. Burch JG, Miller JB. Evaluating crown contours of a wax pattern. *J Prosthet Dent.* 1973;30(4):454-8.
15. Koidis PT, Burch JG, Melfi RC. Clinical crown contours: contemporary view. *J Am Dent Assoc.* 1987;114(6):792-5.
16. Croll BM. Emergence profile in natural tooth contour. Part I: photographic observations. *J Prosthet Dent.* 1989;62(1):4-10.
17. Meijering AC, Peters MC, DeLong R, Pintado MR, Creugers NH. Dimensional changes during veneering procedures on discoloured teeth. *J Dent.* 1998;26(7):569-76.
18. Padbury Jr A, Eber R, Wang HL. Interactions between the gingiva and the margin of restorations. *J Clin Periodontol.* 2003;30(5):379-85.
19. Croll BM. Emergence profile in natural tooth contour. Part II: clinical considerations. *J Prosthet Dent.* 1990;63(4):374-9.
20. Tjan AHL, Freed H, Miller GD. Current controversies in axial contour design. *J Prosthet Dent.* 1980;44(5):536-9.
21. Kohal RJ, Pelz K, Strub JR. Effect of different crown contours on periodontal health in dogs. Microbiological results. *J Dent.* 2004;32(2):153-9.
22. Ehrlich J, Hochman N. Alterations on crown contour – Effect on gingival health in man. *J Prosthet Dent.* 1980;44(5):523-25.