Biotype Change for the Esthetic Rehabilitation of the Smile

MARIANO A. POLACK, DDS, MS*, **DOUGLAS H. MAHN,** DDS†

ABSTRACT

An esthetic and natural appearing smile is the result of multiple important factors. There must be a harmonious relation between tooth size, shape, proportion, and the periodontium. Successful rehabilitation of a smile often requires an interdisciplinary approach which was applied in the case presented in this article to a patient with multiple esthetic challenges. Treatment included management of canines in the lateral incisor positions, proportionally small teeth, and excessive gingival display. Good communication and coordination of care between the surgical and restorative partners produced a pleasing outcome facilitated by periodontal surgery resulting in a modification of the gingival biotype.

CLINICAL SIGNIFICANCE

Smile design including crown lengthening and biotype modification can be used to create an esthetic and natural appearing restorative result.

(J Esthet Restor Dent 25:177–186, 2013)

INTRODUCTION

The dental profession is on a continuous quest to replicate the ideal natural dentition.[1] In order to obtain a highly esthetic result when restoring a patient's smile, the clinician must consider not just the individual features of each tooth but also the effect different tooth forms generate when arranged next to each other. In addition, the relationship between teeth, soft tissue, and the patient's facial characteristics must be taken into account. Proper tooth size, tooth shape, tooth-to-tooth proportion, and symmetry are influenced by the gingival architecture.[2–4] Therefore, an attractive smile is the result of, among other factors, a harmonious relationship between teeth and the periodontium. Controlling the amount of gingival display and arrangement of the gingival contours is also an important aid in the development of an esthetic smile. Furthermore, when congenitally missing teeth are involved, selecting the appropriate adjunctive orthodontic-restorative treatment is of paramount importance.[5–7] A comprehensive and interdisciplinary approach, therefore, may be necessary to achieve ideal results.[2–4]

The functional and esthetic requirements of restorative dentistry direct the periodontal component of treatment. Clinical crown lengthening surgery (ostectomy) may be required to provide sufficient amounts of tooth structure for ideal tooth preparation and restoration.[8,9] Management of the relationship between restorative margins and the periodontium is required to avoid violation of biological width.[10] In addition, judicious reduction of prominent bony ridges (alveoloplasty) can create a hard tissue foundation that proves more esthetic in patients with significant gingival reveal. Selectively reducing the thickness of the labial bone in areas effectively assists in transforming a

*Private Practice, 7431 New Linton Hall Road, Gainesville, VA 20155, USA
†Private Practice, 10610-B Crestwood Drive, Manassas, VA 20109, USA

 DOI 10.1111/jerd.12029

thick biotype into a thinner appearing biotype. Together, clinical crown lengthening and osteoplasty can reduce excessive gingival display and improve the esthetics of the gingival architecture.

Some of the guidelines proposed to aid with smile design include recommendations for teeth proportions,[11,12] as well as suggestions for varying teeth arrangements according to age, sex, and personality, to name a few.[13] In addition, studies have been conducted to determine the perception of laypersons and dental professionals about changes in anterior tooth size, alignment, and their relationship with the surrounding soft tissues.[14,15] This information can be utilized as a basis for smile design, as it will enhance the final restorative outcome.

This article will demonstrate the principles of restoratively directed clinical crown lengthening surgery and osteoplasty of surrounding bone while reviewing some of the guidelines of esthetic smile design. In the following case, a comprehensive and interdisciplinary approach was necessary for the rehabilitation of the patient's smile.

CASE REPORT

A 54-year-old nonsmoker female presented with a chief concern of overall dissatisfaction with her smile (Figure 1). She had a history of orthodontic treatment. As part of this treatment, the maxillary canines were orthodontically moved into the position of the congenitally missing lateral incisors. Composites were placed as a provisional esthetic solution by the orthodontist to close the diastemas until the definitive treatment was completed (Figure 2). The patient was initially seen by the authors after this treatment had been completed. The almond shape of the canines in the lateral incisor site created an unnatural appearance. Her teeth appeared short, and she had excessive gingival display. The gingival morphology was thick and flat, with prominent bony ridges over sites #6, 7, 10, and 11. The inability to visualize a periodontal probe outline when placed in the gingival sulcus suggested a thick biotype.[16] The particularly prominent eminence in sites #7 and 10 further detracted from her appearance. Clinical crown width-to-length ratios were greater than 85%. To achieve pleasing proportions, the incisal edges of sites #7 through 10 needed to be lengthened by approximately 0.5 mm. In addition, the gingival margins of site #6 and 11 needed to be moved apically by 3 mm, sites #7 and 10 by 2 mm, and sites #8 and 9 by 1 mm. This would achieve ideal proportions between 75% and 80%. A diagnostic wax-up was done following these guidelines and presented to the patient for approval. Several treatment plans were discussed with the patient including additional orthodontics to distalize the canines. The lateral incisor sites could then be restored with tooth-supported restorations or single-tooth implants. Alternatively, orthodontics could have been used to idealize the current tooth position. Having just

FIGURE 1. Preoperative smile showing excessive gingival display.

FIGURE 2. Preoperative clinical view showing short teeth and prominent periodontium.

DOI 10.1111/jerd.12029

completed orthodontics, the patient rejected these solutions. The patient accepted a treatment plan that included crown lengthening (crestal and labial bone recontouring) and feldspathic porcelain veneers from sites #6 to 11.

Local anesthesia was achieved with 2% lidocaine with 1:100,000 epinepherine. Initial incisions were made using a #15 Bard-Parker scalpel blade from the facial of the maxillary right second bicuspid to the left second bicuspid. The incision line followed the given instructions of the prosthodontist for desired increase in clinical crown lengthening. The excess gingiva was removed (Figure 3). The new gingival margins were found to be at or slightly apical to the cementoenamel junctions (CEJs).

Upon reflection of full-thickness mucogingival flaps, thick crestal bone levels were in close proximity (<3 mm) to the new gingival margins (Figure 4). Crestal bone levels were recontoured to at least 3 mm from the gingival margin to accommodate the biological width (Figure 5). Reduction of prominent facial alveolar bone was then performed in a manner to support a more natural gingival morphology. Care was taken not to create root dehiscences or fenestrations. To maintain the volume of the interdental papillae, the interdental bone and gingiva were minimally treated. The gingival flaps were secured in the proper position using a continuous 4.0 chromic gut suture (Ethicon, Patterson Dental, St. Paul, MN, USA) (Figure 6).

The patient was prescribed a nonsteroidal anti-inflammatory analgesic and instructed to rinse twice daily rinse with 0.12% chlorhexidine gluconate (Peridex, Proctor & Gamble, Cincinnati, OH, USA) for 1 week. At the 1-week postoperative appointment, sutures were removed, and the patient was instructed to perform excellent oral hygiene.

FIGURE 3. Initial incisions developing ideal tooth proportions.

FIGURE 4. Reflected flaps reveal thick facial bone.

FIGURE 5. Bone recontoured, creating a thinner biotype.

FIGURE 6. Flaps have been secured in proper position.

 DOI 10.1111/jerd.12029

At the 12-week postoperative appointment, the surgical site appeared to have healed well and was free of inflammation (Figure 7). The patient was referred back to the prosthodontist for final restorative treatment.

The patient presented for the restorative phase of treatment approximately 12 weeks after the crown lengthening procedure. An impression of the diagnostic wax-up was made with silicone putty to fabricate a matrix. Bis-acryl provisional material (Protemp 3 Garant, 3M ESPE, St. Paul, MN, USA) was injected into this silicone matrix and seated in the patient's mouth to transfer the diagnostic wax-up intraorally. This esthetic mock-up was approved by the patient and served as a guide for adequate tooth reduction. The six maxillary anterior teeth were then prepared for feldspathic porcelain veneers. Enamel reduction of 0.6 mm was done, utilizing silicone matrices to control incisal, interproximal, and facial reduction (Figures 8–10). Additional reduction on the mesial and distal of the canines would allow contouring the final restorations for these teeth as lateral incisors (Figure 11). Retraction cord (#000 Ultrapack, Ultradent, South Jordan, UT, USA) was packed, and the finish lines were placed at the gingival crest. An additional thickness of retraction cord was inserted (#1, Ultrapak), and photographs were taken with shade tabs next to the prepared teeth to communicate the stump shade to the laboratory technician (Figure 12). A final impression was made with polyvinyl siloxane (Exafast, GC America, Alsip, IL, USA). Next, the teeth were spot-etched and bonded. To fabricate the provisional restorations, a bis-acryl provisional material (Protemp 3 Garant, 3M ESPE) was inserted into the silicone matrix, which was then seated

FIGURE 7. After 12 weeks, improved tooth proportions and biotype are evident.

FIGURE 8. Initial facial preparation with depth guides.

FIGURE 9. The silicone index allows controlled incisal and interproximal reduction of the teeth.

FIGURE 10. The index in place showing adequate facial reduction.

DOI 10.1111/jerd.12029

FIGURE 11. Intraoral view of the finished tooth preparations.

FIGURE 12. Shade tabs and digital photographs were used to communicate hue, value, and chroma to the laboratory.

FIGURE 13. Feldspathic porcelain veneers on master model.

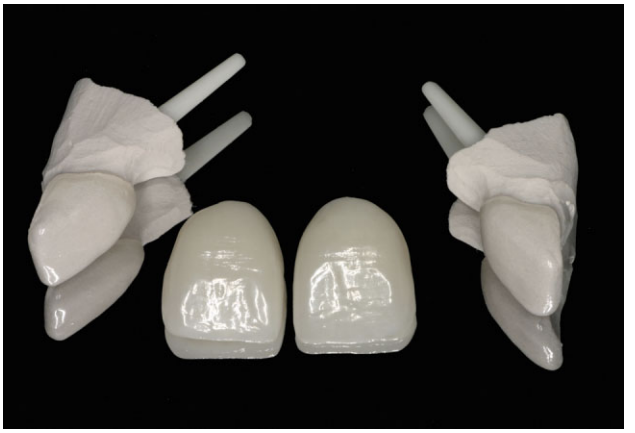

FIGURE 14. Veneers for the maxillary central incisors with their respective dies. Extending the finish lines lingually allows proper closure of the diastemas.

on the prepared teeth. After polymerization, the matrix was removed, and the bonded provisional veneers were left on the teeth after careful intraoral finishing and adjusting. Approximately 3 weeks later, the provisional restorations were removed, the teeth cleaned with pumice. The veneers (Creation, Jensen Dental, North Haven, CT, USA) were tried individually on each prepared tooth (Figures 13 and 14). Interproximal contacts, marginal fit, contours, surface texture, shade match, and overall esthetics were evaluated. The patient approved the restorations. The feldspathic veneers were etched with hydrofluoric acid, silanated, and adhesively cemented with a resin cement (Calibra, Dentsply International, York, PA, USA).

The biotype had been modified, the excessive gingival display when smiling was eliminated, and the overall appearance of the patient's smile was improved (Figures 15–19).

DISCUSSION

Had the restorative and surgical team members been included in the treatment planning of the case prior to orthodontic treatment, a different approach than canine substitution could have been used. Canine substitution creates several challenges. First, maxillary canines usually exhibit more apically positioned gingival

 DOI 10.1111/jerd.12029

FIGURE 15. Incisal view depicts creation of esthetic archform with natural canine and incisal relationships. Black background added for contrast.

FIGURE 16. Intraoral postoperative result showing a harmonious appearance.

margins than the laterals. When apical to the central incisors, these irregularities could be considered unaesthetic. Second, maxillary canines are triangular. After canine substitution, their contact with the central incisors may lead to open gingival embrasures. In addition to the aesthetic challenge, plaque frequently accumulates in open embrasures leading to gingival inflammation.[17] Orthodontic treatment that opens the lateral incisor sites may have reduced the amount of tissue recontouring that was required. In addition, having the canines in their natural position would have allowed a more ideal final result.

The patient also rejected limited orthodontic treatment that could have facilitated the restorative process. Previous orthodontic treatment left the canine's middle lobe protruding facially. Moving the canines lingually would have reduced concerns about preserving enamel during preparation and aided the restoration of proper arch form. In addition, periodontal and restorative procedures could have been minimized, and a more ideal result and long-term prognosis could have been achieved. This emphasizes the importance of interdisciplinary treatment planning.[6,7]

Presurgical planning included determining the amount of tooth exposure that would allow creation of desired height-to-width ratios.[18,19] Clinical crown lengthening

FIGURE 17. Extraoral postoperative view depicts a highly esthetic result.

involves removal of hard and soft periodontal tissues to gain supracrestal tooth length and re-establishment of the biological width.[20] The concept of biological width was the result of the histological description of the dentogingival complex by Gargiulo and colleagues.[21]

Precise management of the interdental papillae area was very important. Tarnow and colleagues found that the interdental papillae completely filled the embrasure space 98% of the time when the distance from the interproximal contact to the crestal bone was 5 mm or less.[22] An increase of only 1 mm would reduce the frequency of papillae completely filling the embrasure space to 56% of the time. In order to minimize

DOI 10.1111/jerd.12029

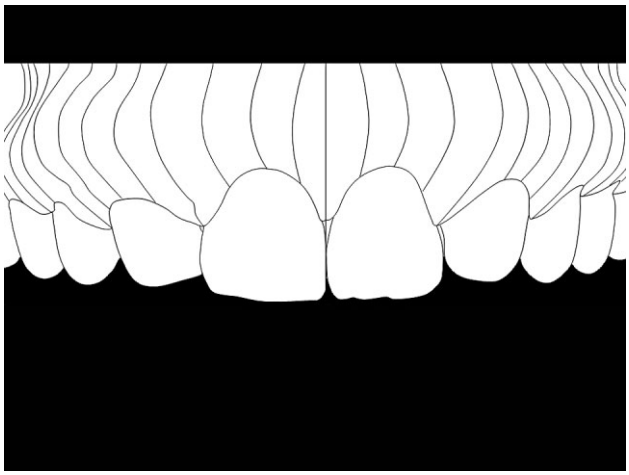

FIGURE 18. Line diagram depicts preoperative dentoalveolar contours and unaesthetic tooth proportions.

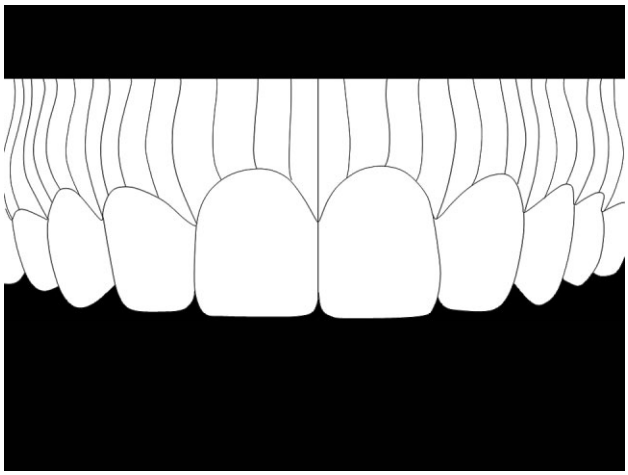

FIGURE 19. Line diagram showing postoperative improvements achieved by biotype modification, crown lengthening, and esthetic rehabilitation.

this risk, no bone supporting the interdental papillae was removed on the patient presented here.

The visible soft tissue architecture plays an important role in developing an esthetic smile. Ochsenbein and Ross divided the gingival morphology into two types, thin and scalloped versus thick and flat.[23] It was proposed that the gingiva closely followed the contours of the underlying bone. Seibert and Lindhe coined the term "periodontal biotype" to categorize the gingiva.[24] In addition, Kois suggested a biotype classification relating the position of the CEJ to the crest of bone.[25] In thick biotypes, the CEJ was <3 mm from the crest of bone. This has been confirmed in a later study.[26] Failure to properly manage this condition may increase the susceptibility of impingement on the biological width.

Kan and colleagues[16] and Fu and colleagues[27] demonstrated the reliability of probe visibility with in the gingival sulcus as an accurate method of assessing gingival biotype. Periodontal probe outlines, deemed not visible when placed in the gingival sulcus, indicated a thick biotype. Recent studies using cone beam computed tomographs (CBCTs) confirmed a positive correlation between the labial thickness of the soft tissue and bone plate.[26,27] In other words, a thick periodontal biotype was associated with a thicker bony labial plate.[26]

In the patient presented here, bony ridges were particularly prominent over sites #6, 7, 10, and 11, and a periodontal probe placed in the sulcus could not be detected. In sites #6, 7, 10, and 11, in particular, the CEJ was <3 mm from the crest of bone. Consistent with the CBCT studies previously mentioned, surgical access confirmed the presence of thick labial bone and bony prominences. Therefore, the patient presented fits the clinical description of a thick and flat biotype. Osseous recontouring was deemed necessary not only to achieve required tooth proportions but also to accommodate the biological width. Thinning of the buccal plate was needed to reduce excessively prominent bony ridges. Because a thin biotype strongly correlates with a thinner labial plate[26] and the gingival morphology was changed from flat to scalloped, the biotype in this patient was effectively modified from thick to thin.

At the 8-week postoperative appointment, the surgical site was found to be healing well. Given these findings, the patient was advised to begin with the restorative treatment at approximately 12 weeks. Lanning and colleagues found that the position of the free gingival margin, periodontal attachment, and bone levels remained stable between 12 and 18 weeks.[20]

Esthetic perceptions and chief concerns can vary between dentists and laypeople.[14] In this case, one of

 DOI 10.1111/jerd.12029

the patient's main concerns was the excessive gingival display of her smile. A smile that displays more than 3 mm of gingiva tends to be considered unattractive by patients.[28] The superior lip line fit the criteria of being high, as defined by Tjan and colleagues.[29] In addition, the lower edge of the upper lip took a rather convex shape across the face further increasing tooth and gingival display.[30] Excessive gingival display was further aggravated by the presence of clinically short teeth and prominent bony ridges.

The "golden proportion" was one of many mathematical theorems proposed to supply clinicians with guidelines to determine the relative widths of the six maxillary anterior teeth as viewed directly from the anterior. These suggestions can provide a starting point for smile design. However, the scientific literature has shown that these guidelines may be too rigid for dentistry.[31,32] Preston has shown that a golden proportion relationship between maxillary centrals and laterals only existed in 17% of the patients studied.[31] Strict adherence to this rule can result in excessive narrowness of the maxillary arch and compression of the lateral segments.[33] Ward has also suggested that the golden proportion should be reconsidered because it was found to lead to the least pleasing and least accepted tooth-to-tooth width relationship among dentists and patients in the United States.[34] Conversely, dominance appears to be the most important parameter of facial esthetics.[33] Because the central incisor is the dominant tooth of the smile, defining proper incisal edge length becomes critical. In general, the incisal edge position should be harmonized with the lower lipline. The incisal plane can then be designed as a convex arc that follows the curvature of the lower lip during smiling.[29] Anteroposteriorly, the incisal edge should be contained within the inner border of the lower lip to allow proper pronunciation of "f" and "v" sounds.[35,36] For this patient, desired incisal edge position and phonetics were verified with the intraoral esthetic mock-up prior to tooth preparation.

Tooth proportion (width-to-length ratios × 100) is a reliable element of smile design.[37] Proportions between 75% and 80 % are considered ideal, whereas proportions above 85% make teeth seem excessively short and square.[38] In the clinical case presented here, crown lengthening was dictated by the need to avoid this problem. Closing a patient's diastemata will increase tooth width, therefore increasing the width-to-length proportion. To re-establish adequate width-to-length ratios in the patient presented, the gingival margins were moved apically, plus the restorations were lengthened incisally by approximately 0.5 mm. Greater interproximal tooth reduction was done on the canines to maintain pleasing width-length ratios when restoring them as lateral incisors in the final restorations. The combination of ideal tooth proportions and a convex incisal curvature generated radiating symmetry, which provided a more youthful appearance to the smile.[39]

Advances in ceramic restorations have greatly transformed esthetic dentistry. Porcelain veneers are frequently the restoration of choice when the goal is to modify tooth form, position, and/or color. They can restore appropriate rigidity to the crown and have the benefit of preserving sound tooth structure over full-coverage restorations.[40] Veneers, therefore, were deemed the ideal restoration for this case.

CONCLUSION

A comprehensive and interdisciplinary approach is often necessary to achieve optimal results. Smile design will generate restorative goals that will dictate and direct adjunct procedures to enhance the esthetic outcome. Clinical crown lengthening can provide additional tooth structure for restoration, whereas biotype modification can create a more natural soft tissue architecture.

DISCLOSURE

The authors do not have any financial interest in the companies whose products are included in this article.

REFERENCES

1. Morley J, Eubank J. Macroesthetic elements of smile design. J Am Dent Assoc 2001;132(1):39–45.

 DOI 10.1111/jerd.12029

2. Ohyama H, Nagai S, Tokutomi H, Ferguson M. Recreating an esthetic smile: a multidisciplinary approach. Int J Periodontics Restorative Dent 2007; 27(1):61–9.
3. Lee EA, Jun SK. Aesthetic design preservation in multidisciplinary therapy: philosophy and clinical execution. Pract Proced Aesthet Dent 2002;14(7):561–9; quiz 70.
4. Chu SJ, Hochman MN. A biometric approach to aesthetic crown lengthening: part I—midfacial considerations. Pract Proced Aesthet Dent 2008;20(1):17–24; quiz 26.
5. Kokich VO, Jr, Kinzer GA. Managing congenitally missing lateral incisors. Part I: canine substitution. J Esthet Restor Dent 2005;17(1):5–10.
6. Kinzer GA, Kokich VO, Jr. Managing congenitally missing lateral incisors. Part III: single-tooth implants. J Esthet Restor Dent 2005;17(4):202–10.
7. Kinzer GA, Kokich VO, Jr. Managing congenitally missing lateral incisors. Part II: tooth-supported restorations. J Esthet Restor Dent 2005; 17(2):76–84.
8. Chu SJ, Hochman MN, Fletcher P. A biometric approach to aesthetic crown lengthening: part II—interdental considerations. Pract Proced Aesthet Dent 2008;20(9):529–36.
9. Wagenberg BD, Eskow RN, Langer B. Exposing adequate tooth structure for restorative dentistry. Int J Periodontics Restorative Dent 1989;9(5):322–31.
10. Reeves WG. Restorative margin placement and periodontal health. J Prosthet Dent 1991; 66(6):733–6.
11. Levin EI. Dental esthetics and the golden proportion. J Prosthet Dent 1978;40(3):244–52.
12. Lombardi RE. The principles of visual perception and their clinical application to denture esthetics. J Prosthet Dent 1973;29(4):358–82.
13. Rahn AO, Heartwell CM. Textbook of complete dentures. 5th ed. Philadelphia (PA): Lea & Febiger; 1993.
14. Kokich VO, Jr, Kiyak HA, Shapiro PA. Comparing the perception of dentists and lay people to altered dental esthetics. J Esthet Dent 1999;11(6): 311–24.
15. Kokich VO, Kokich VG, Kiyak HA. Perceptions of dental professionals and laypersons to altered dental esthetics: asymmetric and symmetric situations. Am J Orthod Dentofacial Orthop 2006; 130(2):141–51.
16. Kan JY, Morimoto T, Rungcharassaeng K, et al. Gingival biotype assessment in the esthetic zone: visual versus direct measurement. Int J Periodontics Restorative Dent 2010;30(3):237–43.
17. Robertsson S, Mohlin B. The congenitally missing upper lateral incisor. A retrospective study of orthodontic space closure versus restorative treatment. Eur J Orthod 2000;22(6):697–710.
18. Mahn DH. Crown lengthening in the aesthetic zone. Dent Today 2011;30(1):158, 160.
19. Polack MA, Mahn DH. Full-mouth rehabilitation using a multidisciplinary approach: material and periodontal considerations. Pract Proced Aesthet Dent 2008;20(9):569–75; quiz 76.
20. Lanning SK, Waldrop TC, Gunsolley JC, Maynard JG. Surgical crown lengthening: evaluation of the biological width. J Periodontol 2003;74(4):468–74.
21. Gargiulo AW, Wentz FM, Orban B. Dimensions and relations of the dentogingival junction in humans. J Periodontol 1961;32:261–67.
22. Tarnow DP, Magner AW, Fletcher P. The effect of the distance from the contact point to the crest of bone on the presence or absence of the interproximal dental papilla. J Periodontol 1992;63(12):995–6.
23. Ochsenbein C, Ross S. A reevaluation of osseous surgery. Dent Clin North Am 1969;13(1):87–102.
24. Lindhe J, Karring T, Lang NP. Clinical periodontology and implant dentistry. 4th ed. Oxford and Malden (MA): Blackwell; 2003.
25. Kois JC. The restorative-periodontal interface: biological parameters. Periodontol 2000 1996;11:29–38.
26. Cook DR, Mealey BL, Verrett RG, et al. Relationship between clinical periodontal biotype and labial plate thickness: an in vivo study. Int J Periodontics Restorative Dent 2011;31(4):345–54.
27. Fu JH, Yeh CY, Chan HL, et al. Tissue biotype and its relation to the underlying bone morphology. J Periodontol 2010;81(4):569–74.
28. Allen EP. Use of mucogingival surgical procedures to enhance esthetics. Dent Clin North Am 1988;32(2):307–30.
29. Tjan AH, Miller GD, The JG. Some esthetic factors in a smile. J Prosthet Dent 1984;51(1):24–8.
30. Dong JK, Jin TH, Cho HW, Oh SC. The esthetics of the smile: a review of some recent studies. Int J Prosthodont 1999;12(1):9–19.
31. Preston JD. The golden proportion revisited. J Esthet Dent 1993;5(6):247–51.
32. Mahshid M, Khoshvaghti A, Varshosaz M, Vallaei N. Evaluation of "golden proportion" in individuals with an esthetic smile. J Esthet Restor Dent 2004;16(3):185–92; discussion 93.
33. Magne P, Gallucci GO, Belser UC. Anatomic crown width/length ratios of unworn and worn maxillary teeth in white subjects. J Prosthet Dent 2003;89(5): 453–61.
34. Ward DH. Proportional smile design using the recurring esthetic dental (RED) proportion. Dent Clin North Am 2001;45(1):143–54.

 DOI 10.1111/jerd.12029

35. Fradeani M. Evaluation of dentolabial parameters as part of a comprehensive esthetic analysis. Eur J Esthet Dent 2006;1(1):62–9.
36. Pound E. Let /S/ be your guide. J Prosthet Dent 1977;38(5):482–9.
37. Chu S. Innovative measurement gauges for correction of tooth size/proportion and gingival architecture. Quintessence Dent Technol 2009;32:63–76.
38. Chiche GJ, Pinault A. Esthetics of anterior fixed prosthodontics. Chicago (IL): Quintessence Pub. Co.; 1994, pp. 53–73.
39. Fradeani M, Barducci G. Esthetic rehabilitation in fixed prosthodontics. Chicago (IL) and London: Quintessence Pub. Co.; 2004, p. 74.
40. Mahn DH, Polack MA. Esthetic rehabilitation of maxillary incisors in conjunction with flapless surgical techniques, an implant zirconia crown, and porcelain veneers. J Esthet Restor Dent 2009;21(5):294–302.

Reprint requests: Mariano Polack, DDS, MS, 7431 New Linton Hall Road, Gainesville, VA 20155, USA; Tel.: 703-753-8753; Fax: 703-753-8994; email: mpolack@comcast.net

This article is accompanied by commentary, "Biotype Change for the Esthetic Rehabilitation of the Smile," Jeff Thomas, DDS

DOI 10.1111/jerd.12030

 DOI 10.1111/jerd.12029