A Biometric Approach to Aesthetic Crown Lengthening: Part I—Midfacial Considerations

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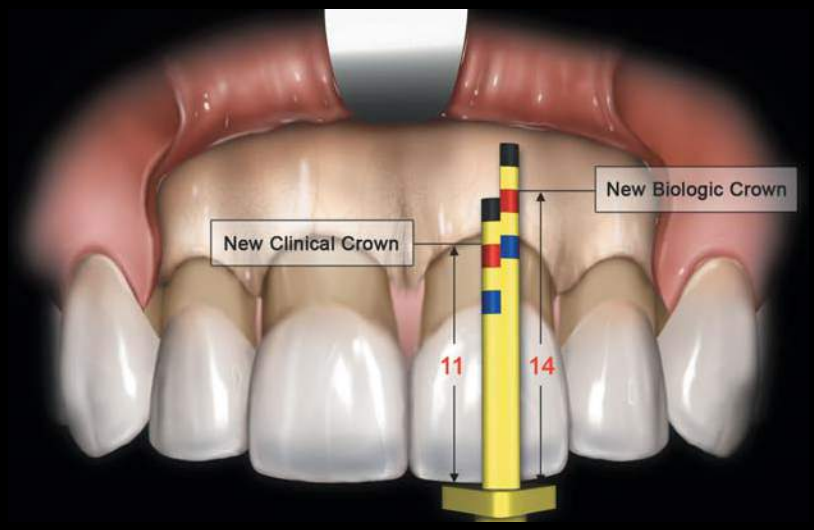

Although human dental anatomy is taught in university curricula, clinicians often witness restorations that are not proportional to one another. Dental restorations should also be proportional to periodontal supporting tissues as an essential aspect of dental anatomy. Measurements can be performed directly on a patient's teeth with aesthetic gauges used to confirm the correct position of the supporting osseous topography. This article demonstrates a technique using these gauges to objectively determine the correct position of the underlying hard tissues and render predictable, aesthetic treatment.

Learning Objectives:
This article highlights the use of aesthetic gauges in a clinical crown lengthening procedure. Upon reading this article, the reader should understand:

- The importance of the dentogingival complex in aesthetic dentistry.
- The role of objective measurement tools for guiding crown lengthening procedures.

Key Words: crown lengthening, midfacial, gauge, dentogingival complex, biologic width

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Contemporary periodontal therapy also encompasses aesthetic treatment where needs are frequently associated with changes in tooth size, shape, proportion, and balance that can negatively affect smile appearance.[1] There exists a synergy between periodontics and restorative dentistry, where the disciplines are interdependent. In aesthetic dentistry where development of the proper tooth size, form, and color of restorations are critical to clinical success, often the periodontal component is considerable and must be addressed for a predictable aesthetic outcome. The need to establish the correct tooth size and thus individual tooth proportion drives the periodontal component of aesthetic restorative dentistry. One specific area of concern is excessively short teeth,[2] where the lack of tooth display and excessive gingival display require clinical crown lengthening that can present a clinical dilemma for the aesthetic-oriented periodontist.

There are a myriad of techniques that have evolved over several decades to treat this situation. Techniques that simplify as well as enhance the quality of treatment can provide substantial benefit to both patients and treating practitioners alike. This article describes an innovative approach to periodontal aesthetic crown lengthening utilizing measurement gauges specifically designed for a predictable surgical outcome, thus setting a new standard of diagnosis and treatment within the aesthetic zone.

Midfacial surgical crown lengthening has traditionally been performed to establish a healthy biologic dimension of the dentogingival complex (DGC) as an adjunct to aesthetic restorative procedures. While considerable variation in the magnitude or length of this complex has been reported, the mean sulcus depth was 0.69 mm, epithelial attachment was 0.97 mm, and the connective tissue was 1.07 mm.[3] Therefore, the total length of the DGC was 2.73 mm. Based on these dimensions, several authors have suggested that 3 mm of supracrestal tooth structure be obtained during surgical crown lengthening.[4,5] Other authors have suggested that supracrestal tooth structure ranges from 3.5 mm to 5.25 mm, depending on the placement of the restorative margin.[6,7] It is important, therefore, to establish a consistent measurement representative of the DGC dimension, which is critical for health and restorative success when performing surgical crown lengthening.

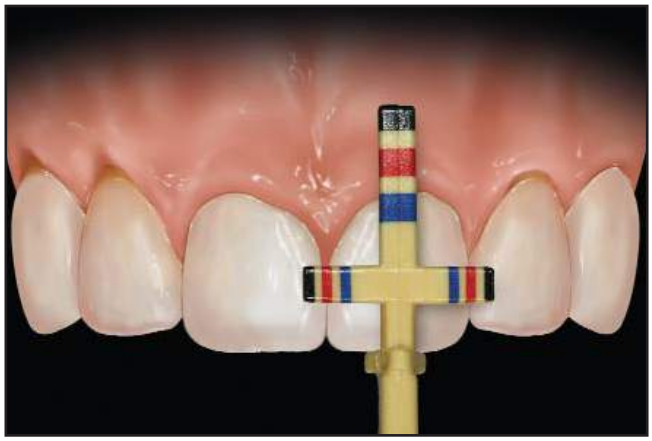

Figure 1. Diagram of T-Bar Proportion Gauge tip (ie, Chu's Aesthetic Gauges, Hu-Friedy Inc, Chicago, IL). Once the desired tooth dimensions are determined, the adjunctive periodontal procedure can be performed whether treatment entails crown lengthening or coverage.

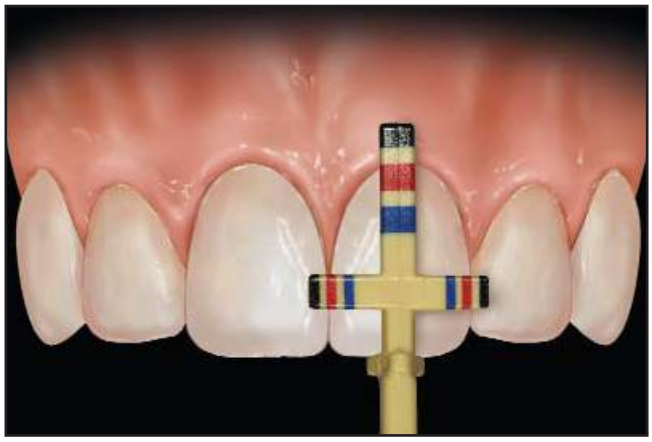

Figure 2. The Proportion Gauge tip is designed for simultaneous width and length measurements of the maxillary anterior dentition. The average central incisor measures 8.5 mm in width by 11 mm in length (see red markings).

Herrero et al noted that establishing a constant and desired surpracrestal tooth length is not routinely achieved during surgical crown lengthening.[8] Walker and Hansen described the fabrication of a surgical template for aesthetic restorative crown lengthening.[9] This, however, required multiple visits to fabricate such a template prior to surgery. In addition, stability of the template during the surgical procedure was questionable and could lead to inconsistent and unsatisfactory results. Lee described a tooth-formed provisional restoration to be used as a removable template for surgical crown lengthening.[10] This approach requires multiple presurgical visits to fabricate,

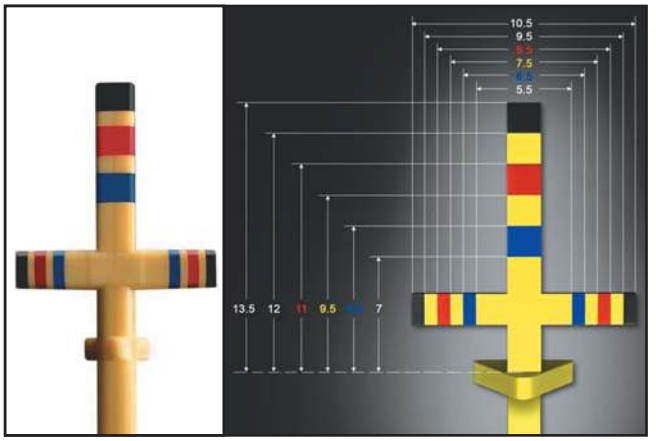

Figure 3. The T-Bar tip encompasses the total range of tooth width and length dimensions of the maxillary anterior dentition. The measurements are mathematically aligned with a preset individual tooth proportion ratio of 78%.

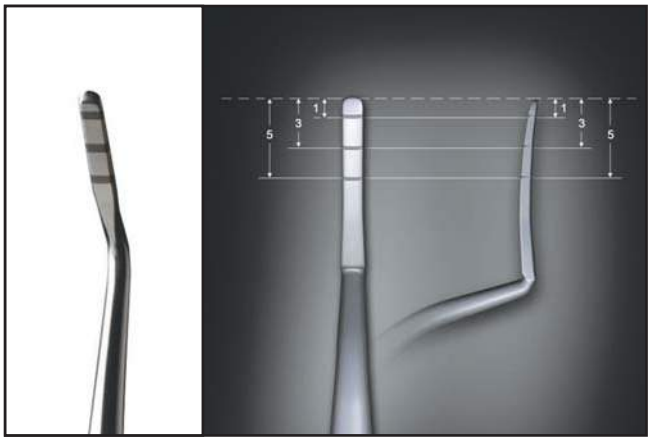

Figure 4. The Sounding Gauge is fabricated to pierce the supracrestal gingival fibers. The curved tip is 1 mm wide and designed to follow the tooth and CEJ anatomic contours.

presents stabilization concerns at the time of surgery, and increases the cost of treatment. These techniques attempted to standardize the amount of supracrestal length of the DGC to be established, yet they all required additional time and laboratory procedures to accomplish.

Traditionally, dental instruments such as periodontal probes have been used as clinical indicators of diseases such as periodontitis, with their numerical values indicative of health or stages of disease.[11] More recently, instrumentation (ie, Chu's Aesthetic Gauges, Hu-Friedy Inc, Chicago, IL) has been created to diagnose and predictably treat aesthetic tooth discrepancies and deformities.[12,13] Aesthetic and anatomic tooth dimensions can now be evaluated and treated by quantitative standards. These innovative aesthetic gauges have been developed to eliminate the subjective aesthetic outcomes afforded by direct visual assessment of aesthetic tooth proportions.

Innovative Instrumentation

Proportion Gauge

The Proportion Gauge (ie, Chu's Aesthetic Gauges, Hu-Friedy Inc, Chicago, IL) enables an objective mathematical appraisal of tooth size ranges in a visual format for the clinician or laboratory technician. Through the use of such instrumentation, the dental professional is able to apply aesthetic values and measurements to a patient chairside (directly) or in the laboratory (indirectly) for projected treatment planning and objective forecasting of the intended treatment outcome (Figure 1). *The correct incisal edge position must be established before any diagnostic and procedure-based measurement is made*. In addition, the correct incisal edge position and tooth size must be determined prior to any irreversible aesthetic periodontal procedure—whether it is clinical root coverage or lengthening.

The Proportion Gauge is designed as a single-handle, double-ended instrument with "T-Bar" and "In-Line" tips screwed into the handle at opposing ends.[13] The T-Bar gauge is used to measure a non-crowded anterior dentition and the In-Line for a crowded dentition. The T-Bar tip features an established rest position at the incisal edge position (ie, an incisal stop); when the gauge is seated accordingly, the practitioner can accurately evaluate its length (vertical arm) and width (horizontal arm) dimensions simultaneously and, therefore, visually assess the correct tooth size and proportion. The width is indicated in 0.5-mm increments of color, each with a vertical mark in corresponding color. Thus, a central incisor with a "red" width of 8.5 mm will be in proper proportion if its height is also the "red" height (ie, 11 mm) (Figure 2).

The measurements of the Proportion Gauge are based on clinical research of range and mean distribution values of individual tooth size, width,[12] and accepted anatomic and clinical proportion ratios.[14,15] The majority of patients were found to have a measurement within ±0.5 mm of the mean averages; central incisors (8 mm to 9 mm),

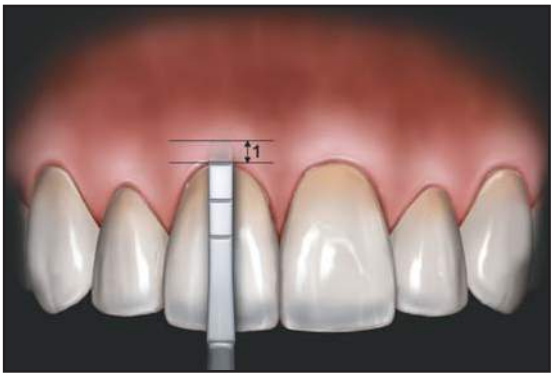

Figure 5. Assessment of the sulcus depth using the Sounding Gauge (ie, Chu's Aesthetic Gauges, Hu-Friedy Inc, Chicago, IL). The first laser marking denotes 1 mm for the average sulcus depth, which can vary between 0.5 mm to 3 mm in health.

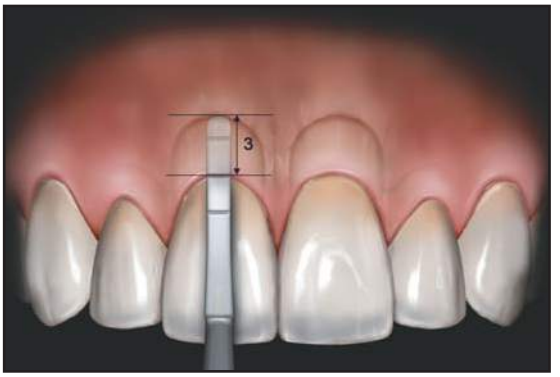

Figure 6. Illustration shows evaluation of the midfacial osseous crest. The second laser marking denotes 3 mm for the average midfacial DGC dimension.

lateral incisors (6 mm to 7 mm), and canines (7 mm to 8 mm), being within these ranges in width (Figure 3).[12]

Sounding Gauge

Midfacial clinical crown lengthening involves a multifaceted decision-making process, with the endpoint being whether hard and soft tissues can be excised and/or should be repositioned.[16] The Sounding Gauge (ie, Chu's Aesthetic Gauges, Hu-Friedy Inc, Chicago, IL) is used in aesthetic periodontal crown-lengthening procedures to determine the level of the bone crest prior to flap reflection. This gauge helps provide quick and simple analysis of the osseous crest location midfacially and interdentally.[16,17] It has a deliberate curvature of the tip coincident with the curvature of the tooth and root—especially at the cementoenamel junction where it is most prominent. This allows easier negotiation of the osseous crest location, particularly in thin biotype cases where the crest is thin and difficult to detect. The tip of the gauge is also wider than that of a periodontal probe at 1 mm in dimension. This increased dimension allows greater stability and confidence during the sounding process.

The Sounding Gauge is fabricated from surgical-grade stainless steel honed to precisely and atraumatically pierce the supracrestal gingival fibers (Figure 4). Laser markings define the average sulcus depth (1 mm) and midfacial DGC (3 mm). In addition, a marking at 5 mm denotes the interdental DGC (5 mm) (Figures 5 through 7).

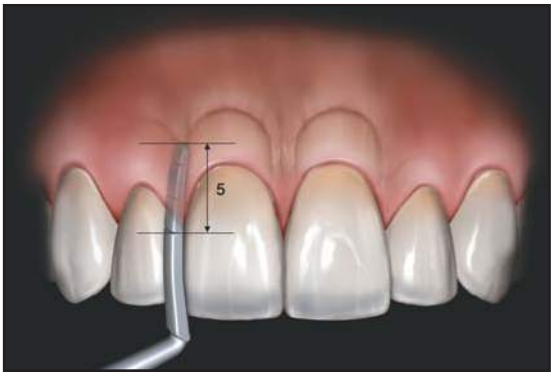

Figure 7. Evaluation of the interproximal osseous crest. The third laser marking denotes 5 mm for the average interdental DGC dimension, understanding that this can vary between 3 mm and 5 mm in health.

Figure 8. Crown Lengthening Gauge accesses clinical crown length (CCL) required based on the results of the T-Bar Proportion Gauge tip in Figure 1. Short arm of tip projects clinical crown height and long arm projects where the bone crest should be relative to CCL after surgery.

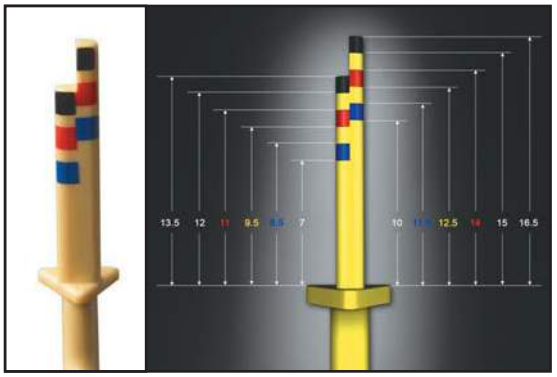

Figure 9. The color coding denotes predetermined teeth at a preset proportion ratio and tooth length. The same colors denote the same teeth no matter what instrument tip is selected and used.

Figure 12. Post-orthodontic therapy reveals a skewed incisal plane on the patient's right side and excess space between the central incisors in the effort to re-establish the midline.

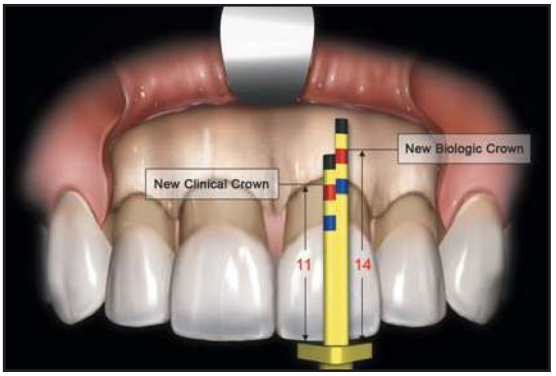

Figure 10. During aesthetic crown-lengthening procedures, simultaneous visualization of CCL and biologic crown length (BCL) allows the clinician to focus on the goal of treatment without question, since the blueprint for osseous resection is clearly delineated.

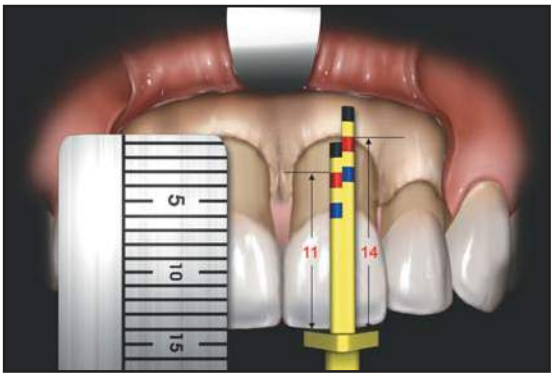

Figure 11. The BLPG tip of the Crown Lengthening Gauge allows precise visual verification that the proper amount and shape of osseous resection was performed to the highest level.

Crown Lengthening Gauge

The Crown Lengthening Gauge (ie, Chu's Aesthetic Gauges, Hu-Friedy Inc, Chicago, IL) has a "BLPG Tip" designed to measure the midfacial length of the anticipated restored clinical crown and the length of the biologic crown (ie, bone crest to the incisal edge) simultaneously during surgical crown lengthening (Figure 8). The BLPG tip is designed to replace existing aesthetic crown-lengthening techniques, employing the use of polymer-based surgical guides or templates. The advantages of the Crown Lengthening Gauge over such conventional means are precision during the procedure, where potential movement of the surgical guide is a non-factor, as well as cost efficiency from decreased time and laboratory procedures required for guide/template fabrication.

The disposable plastic instrument tip with an incisal rest is color coded with a preset midfacial DGC measurement of 3 mm (Figure 9). This is based on the ideal 3-mm DGC or difference recommended between the clinical length and the biologic length of the crown. The color-coded marks on the shorter arm represent the clinical crown length, and the corresponding color markings on the longer arm represent the biologic crown length. During the osseous resection procedure, the visualization of both these parameters simultaneously serves the clinician to focus on the end goal of treatment since the blueprint for bone removal is clearly delineated (Figures 10 and 11). The short arm of the BLPG tip is of the same

Figure 13. One week after insertion of the provisional restoration with re-establishment of the incisal edge position, occlusal plane, midline, and mesial-distal width of the anterior teeth.

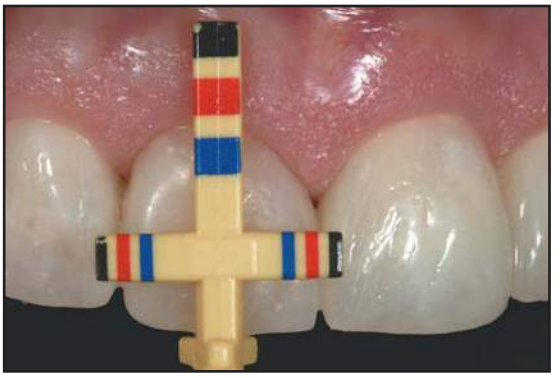

Figure 14. Once the existing crowns are removed and the incisal edge position, midline, and tooth width are corrected, accurate measurement can be made for aesthetic correction.

Figure 15. Sulcus depth of 1 mm to 2 mm, midfacial osseous crest depth of 3 mm, and interproximal osseous crest location of 4 mm can be accurately assessed with the Sounding Gauge.

Figure 16. The BLPG tip is used to measure the midfacial length of the new clinical crown as well as the biologic crown simultaneously. The incisal stop helps position the gauge during measurement.

length and measurement as the long arm of the T-bar tip of the Proportion Gauge (Figures 3 and 9).

Case Presentation

A 54-year-old female patient presented for an aesthetic restorative consultation during orthodontic treatment. She was undergoing orthodontic treatment to correct a deep overbite relationship as well as correct a midline discrepancy. The patient did not like her smile because the preexisting, 20-year-old, full-coverage restorations were wearing and looked artificial. Comprehensive clinical and radiographic examination revealed loss of marginal integrity of the full-coverage restorations with gingival recession exposing the restorative margins. In addition, mild tooth rotations and excess spacing was present following orthodontic treatment (Figure 12). The maxillary and mandibular incisors were proclined with inadequate overjet, overbite, and interarch relationships. The patient exhibited a high smile line with asymmetrical free gingival margin architecture.

Objective Analysis of Tooth Proportion

An initial phase of treatment included orthodontic tooth movement to correct arch form, spacing, and overjet/overbite relationships. The second phase of treatment addressed fabrication of provisional restorations from a diagnostic waxup to reestablish a functional occlusion as well as the correct incisal edge position that harmonized with the aesthetic and phonetic needs of the patient (Figure 13). Assessment of attachment levels was performed in conjunction with the Proportion Gauge, following insertion of the provisional restorations (Figure 14),

Figure 17. The proper amount of osseous resection can be performed quantitatively to establish biologic width without estimation.

Figure 18. An apically repositioned flap was secured with periosteal vertical interrupted sutures and 5-0 chromic gut sutures.

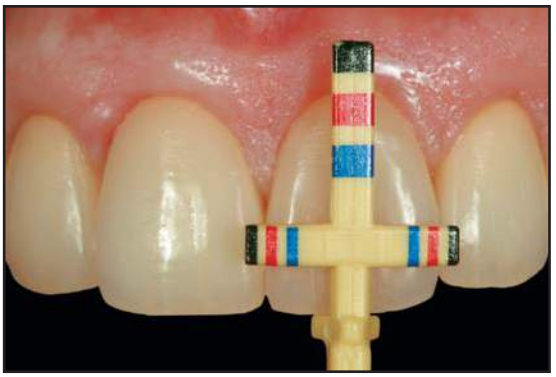

Figure 19. The final tooth size and shape of the restoration was created in the laboratory using the T-Bar tip of the Proportion Gauge and was verified clinically prior to final cementation.

Figure 20. Aesthetic-restorative integration and harmony of the zirconia-based restorations is achieved through predictable planning with the Proportion and Crown Lengthening Gauges.

and Sounding Gauge to accurately identify the gingival sulcus, gingival attachment, and crest of bone, respectively (Figure 15). Tooth size and proportion were found to be undesirable with a width-to-length ratio that was greater then 78% for the maxillary anterior teeth. Inadequate midfacial biologic width was identified on tooth #8(11). Surgical crown lengthening was proposed based on the findings of the gauges (ie, Chu's Aesthetic Gauges, Hu-Friedy Inc, Chicago, IL).

The patient was anesthetized using local anesthesia, 4% articaine HCL 1:200,000 epinephrine, bilateral buccal infiltrations, and bilateral palatal AMSA injections performed using the STA-System (Milestone Scientific, Livingston, NJ). A papilla preservation incision was performed at the interproximal area to retain the integrity of the papilla tissue. An intrasulcular incision was performed over the direct facial of the anterior teeth to expose the underlying crest and facial alveolar bone. Dissection of a full-thickness flap exposed the underlying osseous topography. Direct clinical assessment utilizing the BLPG tip of the Crown Lengthening Gauge indicated the proper amount of osseous resection to be re-established (Figure 16). The proper vertical position to establish a biologic width of 3 mm was determined based on idealized tooth proportions, which were first confirmed with the BLPG tip.

An apically repositioned flap was secured with periosteal vertical interrupted sutures and 5-0 chromic gut sutures (Figure 17). The optimum tooth length and free gingival margin location were established prior to and during crown-lengthening surgery using the T-Bar tip (Figure 18), thus ensuring that the final tooth proportion being

Figure 21. Through predictable correction of tooth size and proportion, a more aesthetically pleasing smile can be achieved that integrates balance and harmony.

established post-healing would be congruent with the final aesthetic-restorative outcome. The patient was recalled at four months, where the amount of clinical crown length established could be verified with the Crown Lengthening Gauge or the Proportion Gauge. Final restorations were fabricated in the laboratory and cemented at six months post-surgery (Figures 19 and 20). The integration of tooth proportion and desired measured amount of osseous resection based on tooth dimensions, proportion, and biologic width made these instruments beneficial when utilized in aesthetic crown lengthening surgery (Figure 21).

Conclusion

Human dental anatomy has remained relatively constant for centuries. While human dental anatomy is taught in the dental curriculum, much too often clinicians witness restorations of teeth that are not proportional to one another (Personal communication, J. Greenberg, 2007). These restorations should also have a basic proportional relationship to periodontal supporting tissues as an essential aspect of dental anatomy.

This is the first technique that uses optimal tooth proportions to determine the correct position of the osseous topography supporting those teeth. Measurements are performed directly on the teeth with disposable and removable aesthetic gauges so that they will not interfere with surgical instrumentation. The gauges can be used repeatedly to confirm the amount of midfacial osseous tissue to be removed. Visual precision without guessing or emotional estimation is vital for successful, predictable, cost-efficient treatment.

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