

Treatment of the Patient with Gummy Smile in Conjunction with Digital Smile Approach



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KEYWORDS

• Gummy smile • Gingival display • Crown length • Porcelain veneers

KEY POINTS

- Gummy smile cases are always esthetically demanding cases.
- This article presents a case treated with an interdisciplinary treatment approach and Digital Smile Approach (DSA) using Keynote (DSA), to predictably achieve an esthetic outcome for a patient with gummy smile.
- In order to formulate a treatment plan that predictably leads to a successful esthetic outcome, the final appearance of the case must be visualized and defined before the initiation of active treatment.
- The importance of using questionnaires and checklists to facilitate the gathering of diagnostic data cannot be overemphasized.
- The acquired data must then be transferred to the design of the final restorations.
- The use of digital smile design has emerged as a powerful tool in cosmetic dentistry to help both the practitioner and the patient visualize the final outcome.

INTRODUCTION

A smile's attractiveness is determined by tooth shapes, position, and color, as well as the extent and healthy appearance of the gingival tissue display. The overall relationship between these elements and the face complete the esthetic determinants.

The authors have nothing to disclose.

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Computer design software has evolved into the major component of the communication between dentists, technicians, and patients. The power of digital technology can now be incorporated into the smile design procedure. Although there are several proprietary digital design services available in the marketplace (Smile Designer Pro, Toronto, Ontario, Canada; Digital Smile Design, Sao Paulo, Brazil). Photoshop software (Adobe Systems, San Jose, CA, USA), PowerPoint (Microsoft Corp, Redmond, WA, USA), or Keynote (Apple Inc, Cupertino, CA, USA) can also be used to facilitate patient input, conceptualization of outcomes, and laboratory communication. The design must be based upon an understanding of macroesthetic and microesthetic concepts regardless of the system used.^{1,2} The primary author used Keynote (as others have done) with a DSA to create a smile design incorporating correction of the patient's chief complaint and information derived from the New York University (NYU) esthetic evaluation form.

Soft tissue surgical periodontal plastic procedures play an important role in the enhancement of smile by helping to optimize the relationships between the 3 primary components: the teeth, the lip framework, and the gingival scaffold.³ Kois⁴ has stated that when attempting to enhance esthetic outcomes, the influence of 2 essential biological concerns must be fully understood. The first, location of the base of the sulcus, influences the cervical termination of tooth preparation and allows for intracrevicular location of the restoration margin. The second, knowledge of location of the osseous crest, is required before altering gingival levels. The so-called gummy smile is largely a result of an unfavorable ratio between upper lip length and gingiva/tooth display. The location of the smile line is also essentially the product of this ratio. The smile line is defined as the ratio between the upper lip and visibility of the gingival tissue and teeth. Smile level is an imaginary line that follows the lower margin of the upper lip and usually has a convex appearance.⁵ Cases exhibiting excessively short teeth and a lack of tooth display are frequently encountered esthetic problems. Excessive gingival display may also be encountered in cases with short teeth. When the incisal edge position is correct, crown lengthening can be used to increase the clinical crown length as a stand-alone esthetic procedure. When the incisal edge position is inadequate and there is excessive gingival display, crown lengthening in conjunction with restorative treatment is indicated. The surgical technique involves apically positioning the gingival margin and may require the removal of supporting bone. The periodontal surgical procedure must also result in a proper biological width and adequate keratinized tissue. Gummy smile can also be the result of altered passive eruption (the alveolar crest is <2 mm from the cemento-enamel junction), gingival overgrowth,⁶ inadequate length of the upper lip, muscular hyper-elevation of the upper lip, and vertical maxillary excess.^{7,8} Cases in which there has been extrusion of the upper teeth, with an associated deep bite, present a related problem.⁹

The initial step in establishing a correct diagnosis and a definitive plan of treatment is through a proper classification of the gingival level. Tjan and colleagues¹⁰ established the smile guidelines standards in the 1980s. Smiles were classified into 3 basic categories (high, average, and low) depending on the exposure of the midfacial cervical margin of the clinical crown relative to the vermilion border. This article shows a step-by-step procedure describing how to optimize the final esthetic outcome with the aid of the digital smile design approach and the proper steps to follow in the diagnosis and treatment planning of a patient with gummy smile.

CASE PRESENTATION

The patient, a Latin American homemaker in her mid-50s, presented with the chief complaint of wanting to improve her appearance. Specifically she sought dental

treatment because she did not like her front teeth and desired to improve her smile (Figs. 1–3).

A medical history was taken, and a comprehensive extraoral and intraoral examination was conducted. The patient had an extensive previous dental history, including crowns, composite restorations, and root canals. An esthetic evaluation of the patient was also performed. This evaluation included mounted models, radiographs, photographs, and an esthetic evaluation form incorporating the changes desired by the patient.

The following problem list was created from the gathered data:

- Localized initial periodontitis (No. 2–3 and No. 6–7)
- Caries No. 2, 3, 5, 13, 19, and 31
- Poorly filled root canals No. 2, 7, and 8
- Overeruption No. 8 and 9
- Excessive maxillary gingival display
- Abrasion No. 21 to 28
- Poor-fitting crowns No. 7, 8, and 9
- A narrow arch form.

Determination of the origin of the problem is extremely important in patients presenting with a gummy smile, which can be skeletal, muscular, dentogingival, or a combination of several or more factors. Knowing the origin of the problem helps to guide the treatment decisions.

Initially, a healthy oral environment was achieved by oral hygiene instruction; localized scaling and root planning on No. 2–3 and No. 6–7; endodontic re-treatment of No. 2, 7, and 8; and composite restorations on No. 2, 3, 19, and 31.



Fig. 1. Full face view demonstrates extensive gingival exposure.



Fig. 2. Smile close-up.

Once hard and soft tissues free of disease were obtained, the final design and position of the restorations were defined by the primary author with the aid of the DSA. The DSA was particularly useful in this case because there was insufficient room for additive mock-up material (usually composite) in the unprepared case. Precisely replicating every detail of the DSA design, strictly adhering to the data flow, enables achievement of the predicted esthetic outcome. A digital caliper was used to measure some reference points on the casts (**Fig. 4**). With the aid of a calibrated virtual digital ruler, the reference points are subsequently transferred to the computer photographs of the patient (**Figs. 5–7**). The newly established incisal edge position, as always, dictated the design of the restorations.

The digitally designed images allowed the patient to visualize the final result and comprehend the issues presented by her current oral condition (**Figs. 8 and 9**). The number of teeth requiring restoration and the need for periodontal surgeries became apparent. The patient's approval to proceed with the treatment was based upon viewing the potential outcome via the DSA software.

The first wax-up was created based on the DSA measurements (**Fig. 10**). The restorations proposed in the wax-up were transferred to the patient's mouth (the mock-up) through the use of a silicone putty matrix (Coltene Lab-Putty, Coltène/Whaledent Inc Cuyahoga Falls, OH, USA) and bisacryl (Luxatemp Ultra, DMG America, Englewood, NJ, USA). The incisal edge position and parallelism to the horizontal reference line were verified. A few minor intraoral modifications were made and followed by an impression of the mock-up. Models were poured on which the final wax-up was



Fig. 3. Retracted intraoral close-up.

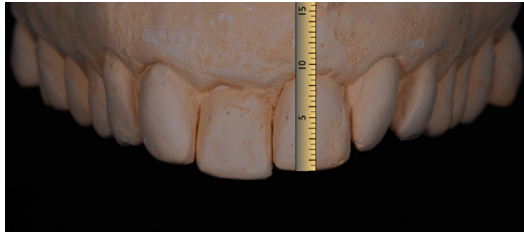


Fig. 4. Calibration of digital ruler on cast.

created. Indexes fabricated from this wax-up were used as the surgical and preparation guides (**Figs. 11–13**).

The esthetic crown lengthening surgery was accomplished, with the aid of the guides, correcting the gingival margin levels. To increase predictability, the procedure was divided into 2 distinct phases. Initially, the old crowns were removed, a mock-up was performed (**Fig. 14**), a gingivectomy was accomplished (**Fig. 15**), and the provisionals were inserted (**Fig. 16**). The biological width was deliberately violated. Dividing the overall periodontal procedure into 2 phases meant shorter appointments and enabled tooth preparation margin position correction. Osseous recontouring to establish an acceptable biological width was accomplished 3 weeks later. A full-thickness flap was raised to allow visualization during the osteoplasty and permit accurate positioning of the gingival margin (**Figs. 17 and 18**).

Six weeks postsurgery, the preparations were modified (**Fig. 19**) and long-term provisionals were placed (Luxatemp). The shape of the provisionals were similar to the contour established in the DSA (**Fig. 20**). Six months postsurgery, final impressions of the prepared teeth were made using retraction cord (Ultrapak, Ultradent Products, Inc, South Jordan, UT, USA) and a polyvinyl siloxane impression material (Aquasil, Dentsply Caulk, Milford, DE, USA). Maximum intercuspation (centric occlusion) bites were recorded (Blu-Bite HP, Henry Schein Inc, Melville, NY, USA). Impressions, bites, clinical pictures, and shades were sent to the laboratory. The models were mounted in centric occlusion on a semiadjustable articulator with a facebow transfer (Artex Articulator System, Amann Girrbach AG, Koblach, Austria).

In consultation with the laboratory, it was decided to fabricate IPS e.max (Ivoclar Vivadent Inc, Amherst, NY, USA) crowns on No. 7, 8, and 9; veneers on No. 6, 10, and 11 in the maxilla; veneers on No. 21 to 27 in the mandible; and onlay veneers



Fig. 5. Calibrated measurement used to measure initial incisal edge exposure.



Fig. 6. Calibrated measurements on photograph of maxillary anterior teeth.

on No. 4, 5, 12, and 13. IPS e.max was chosen for both its esthetic qualities and physical properties. After inspection of the ceramics, transparent shade try-in gel was used to position the restorations on the prepared teeth (Variolink II, Ivoclar Vivadent Inc). The patient was given an opportunity to see the restorations in her mouth and gave her consent before their cementation. A water rinse was used to remove all traces of the try-in gel from the restorations. The internal surfaces of the restorations were scrubbed for 15 seconds with a 35% phosphoric acid solution (Ultra-etch, Ultradent Products, Inc) and ultrasonically cleaned in alcohol for 1 minute. Silane primer (Ultra-dent Products, Inc) was placed on the internal surface of the veneers and allowed to air-dry. Bonding agent (Prime&Bond NT, Dentsply Caulk) was applied and the solvent allowed to evaporate for 30 seconds. The veneered teeth were isolated with rubber dam and Teflon tape, etched with Ultra-etch for 15 seconds, and rinsed with water for 30 seconds. Prime&Bond NT bonding agent was applied to the internal service of the veneers and light-cured for 10 seconds. The restorations were then loaded with the base shade of a dual-cured cement (Variolink II cement transparent) and seated on the teeth. A small brush and floss were used to remove the excess cement before light curing for 40 seconds. The crowns were cemented with RelyX Unicem (3M ESPE, St Paul, MN, USA). A final check of the occlusion was made with articulating paper (Accufilm, Parkell Inc, Edgewood, NY, USA), and minor adjustments were performed.

The gummy smile of the patient was not completely corrected, because of its skeletal origin. Other treatment options were offered to the patient, such as orthodontic treatment and orthognathic surgery, but were declined. Despite these



Fig. 7. Lips, gingival margins, papilla height, and incisal edge are delineated.



Fig. 8. Intraoral DSA.

limitations, the final result achieved in this case demonstrates what may be accomplished using a systematic interdisciplinary approach assisted by DSA (see [Fig. 20](#); [Figs. 21–24](#)).

DISCUSSION

Esthetically driven restorations for the anterior teeth have become an accepted norm in contemporary dental practice. The esthetic objective affects the treatment planning



Fig. 9. Full face DSA.



Fig. 10. Initial wax-up based on DSA measurements.

process. The esthetic wax-up is often used to confirm the treatment plan before definitive preparations. Accumulated diagnostic data guide the design of the final restorations. The patient's requirements, within the confines of biological and functional considerations, also need to be incorporated into the final design. Photoshop design software or a variety of commercially available programs can be used before a conventional wax-up to give direction to the process and to communicate with both the patient and the interdisciplinary professional team (the pictures require calibration). Visualization of the final result is accomplished, and the required logical treatment sequence is conceptualized. A series of photographs, as is required in the International Esthetic Program, and an esthetic evaluation form, such as the NYU College of Dentistry esthetic evaluation form, are prerequisites to performing a digital smile design. The DSA software used for this case required 3 basic photographs: full face with a wide smile and teeth apart, full face at rest, and a retracted view with teeth separated. A 45° view and a profile view are also beneficial. A digital facebow is then created by relating the full face smile to horizontal reference lines such as the interpupillary line. A vertical line establishes the midline relying on glabella, nose, and chin as references. On completion, the smile analysis can be concluded. Horizontal lines drawn on the photograph, namely, tip of the canine to contralateral canine, incisal ridge of one central to the incisal edge of contralateral central, and the dental midline, help to calibrate the features presented on the photograph. A digital ruler calibrated against the patient's model is used to measure the width/length percentage of the central incisors. A variety of tooth shapes, available as templates and chosen with patient input, can be inserted.¹¹ The pink and white evaluation can also be determined as the relationship between the teeth and smile line are readily delineated. All this information is then transferred to a wax-up and subsequently to an intraoral mock-up. This



Fig. 11. Incisal edge mock-up.

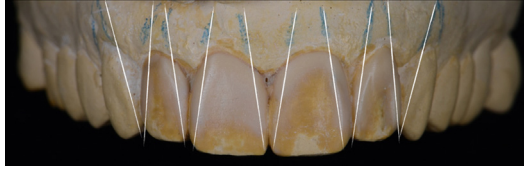


Fig. 12. Final wax-up.

preliminary workup confirmed the need of the patient for esthetic crown lengthening in order to achieve the patient's esthetic goals.

Ideally the amount of gingival display is approximately 1 mm. Excessive gingival display is considered to be more than 3 mm. However, the relationship between gingival and incisor display is a determining factor.¹² As males usually have longer lips, females display more gingiva during maximum smiles.^{13,14} Crown lengthening for this patient was esthetically driven and depended on the position of the envisioned incisal edge and the length of the tooth desired.^{15,16} Communication between the restorative dentist and the surgeon is required in order to delineate the anticipated tooth position and free gingival margin location. Before surgery, the soft tissue should be measured by sounding to crestal bone in order to approximate the amount of osseous resection required.¹⁷ The surgery can be done in either of the following 2 ways.¹⁸ In the first method, the osseous component is completed with the height of bone placed in the position required to maintain the biological width.¹⁹ The flap is placed back in its original position. After an appropriate healing time, a gingivectomy places the soft tissue in the correct position and reestablishes an acceptable the biological width. The teeth may then be provisionalized. This technique reduces the rebound effect of the soft tissue eliminating the need for more surgery. A second technique requires a gingivectomy, teeth preparation at the new gingival level, and provisionals placed. After that procedure, a full-thickness flap is raised to allow a bone level repositioning by the surgeon with osseous recontouring as needed to re-create adequate biological width. This second technique can be staged into different procedures. In the first stage, gingivectomy and provisionalization are pursued. After a few weeks, the full-thickness flap can be raised to re-create the new apically positioned biological width. Placement of the provisional restorations hinders the formation of the dentogingival complex, but if only allowed to remain for 2 to 4 weeks, it will not provoke an inflammatory reaction. The final gingival margin location and stability depend on the biotype, extent of osteotomy, and flap adaptation. Ideally, a waiting period of 3 months is suggested before proceeding to the final restorative phase. As 2 to 3 mm of keratinized tissue needs to remain after surgery, the amount of keratinized tissue initially present is important. Advantageously, the patient does not have any time during which unappealing roots are exposed.



Fig. 13. Mock-up indexes.



Fig. 14. Mock-up as a surgical stent.



Fig. 15. Gingivectomy and preparation modification.



Fig. 16. Provisionalization.

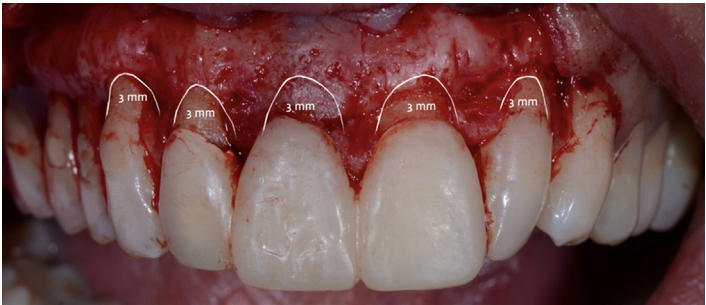


Fig. 17. Exposure of osseous crest.

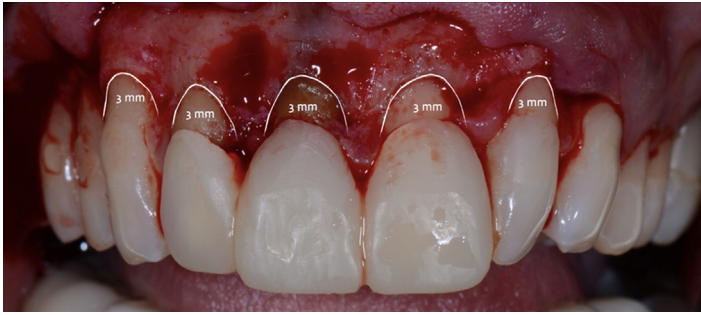


Fig. 18. Bone recontouring.



Fig. 19. Final preparations.



Fig. 20. DSA versus provisionals.



Fig. 21. Final restorations.



Fig. 22. Smile before and after.



Fig. 23. Full face before and after.



Fig. 24. Final smile close-up.

SUMMARY

The DSA, as used in the case presented here, is a powerful tool for use in esthetic dentistry. DSA is a diagnostic instrument, patient education and marketing tool, education tool for dentists, and an aid in laboratory communication. DSA provides feedback as to the results achievable with minimum restorative dentistry. When exploited to its fullest potential, it provides insights into the predictability of the treatment, reduces mistakes, and allows to control of risk factors (see [Fig. 24](#)). Optimizing outcomes by assessing the origin of the problems is the key point in determining the need for specialty involvement in the treatment of a patient with gummy smile. Digital visualization of the final outcome and an understanding of the limitations of each treatment procedure guide best practice decisions for a given case.

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REFERENCES

1. McLaren EA, Culp L. Smile analysis - the Photoshop smile design technique: part 1. *J Cosmet Dent* 2013;29:94–108.
2. McLaren EA, Garber DA, Figueira J. The Photoshop smile design technique (part 1): digital dental photography. *Compend Contin Educ Dent* 2013;34:772–9.
3. Garber DA, Salama MA. The aesthetic smile: diagnosis and treatment. *Periodontol* 2000 1996;11:18–28.
4. Kois JC. Altering gingival levels: the restorative connection part I: biologic variables. *J Esthet Restor Dent* 1994;6:3–7.
5. Oliveira MT, Molina GO, Furtado A, et al. Gummy smile: a contemporary and multidisciplinary overview. *Dent Hypotheses* 2013;4:55–60.
6. Ong M, Tseng SC, Wang HL. Surgical crown lengthening. *Clinic Adv Periodontics* 2011;1(3):233–9.
7. Monaco A, Streni O, Marci MC, et al. Gummy smile: clinical parameters useful for diagnosis and therapeutical approach. *J Clin Pediatr Dent* 2004;29:19–25.
8. Hwang WS, Hur MS, Hu KS, et al. Surface anatomy of the lip elevator muscles for the treatment of gummy smile using botulinum toxin. *Angle Orthod* 2009;79:70–7.
9. Kim TW, Kim H, Lee SJ. Correction of deep overbite and gummy smile by using a mini-implant with a segmented wire in a growing Class II DIVISION 2 patient. *Am J Orthod Dentofacial Orthop* 2006;130:676–85.
10. Tjan AH, Miller GD, The JG. Some aesthetic factors in a smile. *J Prosthet Dent* 1984;51:24–8.
11. Coachman C, Calamita M. Digital Smile Design: A Tool for Treatment Planning and Communication in Esthetic Dentistry. *Quintessence Dent Technol* 2012;35:103–11.
12. Khan F, Abbas M. Frequency of gingival display during smiling and comparison of biometric measurements in subjects with and without gingival display. *J Coll Physicians Surg Pak* 2014;24:503–7.
13. Al-Jabrah O, Al-Shammout R, El-Naji W, et al. Gender differences in the amount of gingival display during smiling using two intraoral dental biometric measurements. *J Prosthodont* 2010;19:286–93.
14. Al-Hababbeh R, Al-Shammout R, Al-Jabrah O, et al. The effect of gender on tooth and gingival display in the anterior region at rest and during smiling. *Eur J Esthet Dent* 2009;4:382–95.

15. Chu SJ, Hochman MN. A biometric approach to aesthetic crown lengthening: part I—midfacial considerations. *Pract Proced Aesthet Dent* 2008;20:17–24.
16. Chu SJ, Hochman MN, Fletcher P. A biometric approach to aesthetic crown lengthening: part II—interdental considerations. *Pract Proced Aesthet Dent* 2008;20:529–36.
17. Perez JR, Smukler H, Nunn ME. Clinical evaluation of the supraosseous gingivae before and after crown lengthening. *J Periodontol* 2007;78:1023–30.
18. Sonick M. Esthetic crown lengthening for maxillary anterior teeth. *Compend Contin Educ Dent* 1997;18:807–12.
19. Lee EA. Aesthetic crown lengthening: classification, biologic rationale, and treatment planning considerations. *Pract Proced Aesthet Dent* 2004;16:769–78.