RESTORING TETRACYCLINE-STAINED TEETH WITH FELDSPATHIC PORCELAIN VENEERS

When individuals who are somewhat knowledgeable about esthetic dentistry present for treatment, it is incumbent upon dentists and their teams to develop a trusting relationship with them.



David Leo Finkelstein, DDS John Calamia, DMD

Abstract

Proper treatment planning enables execution of the most appropriate restorative techniques, preservation of healthy tooth structure, and realization of esthetic expectations. However, developing a comprehensive treatment plan requires a combination of subjective esthetic information and objective clinical and functional findings. This article demonstrates the step-by-step application of communication, diagnostic, and collaborative techniques that contribute to successful treatment. The sequentially planned clinical protocol, proven restorative modality, and results achieved are also discussed.

Key Words: tetracycline staining, porcelain veneers, esthetic dentistry, minimally invasive

Introduction

Information available via today's ubiquitous social media has contributed to increased patient awareness of the possible esthetic outcomes that can be achieved with certain dental procedures (e.g., veneers, whitening). Unfortunately, patients eager to enhance an unattractive smile can become easily confused or even misled—by the overabundance of online information regarding various treatment options, which may or may not be appropriate for their specific situation.

Therefore, when individuals who are somewhat knowledgeable about esthetic dentistry present for treatment, it is incumbent upon dentists and their teams to develop a trusting relationship with them so they can educate them about their condition, as well as guide them in their treatment-acceptance decisions. A mutually satisfying dentist-patient relationship is predicated on the clinician's skills in three key areas.

1. Listening carefully to, and understanding, the patient's concerns and desires. Understanding a patient's esthetic and functional concerns and desires can be challenging. Analyzing and critiquing smile esthetics, as well as ultimately creating the illusion of beauty, encompasses both objective observation and subjective evaluation of the teeth and surrounding structures.1 Although dentists understand that many factors influence smile esthetics (e.g., facial contours, golden proportion, incisal embrasures, tooth spacing, gingival zeniths, bilateral negative space, and smile line placement),² patients may be unable to identify or express their expectations in terms of specific yet critical smile components. Using a simple smile evaluation form (Figs 1 & 2) can greatly enhance both patient understanding of the esthetic and functional criteria that must be considered and incorporated into their treatment, and their ability to communicate what they do not like and want to change in their smile.

A dentist's treatment objective encompasses functionally and physiologically sound, longlasting esthetic restorations surrounded by healthy supporting hard and soft tissues.

- 2. Detecting, diagnosing, and discussing existing dental problems, along with their causes and etiology, that could affect treatment decisions. Successful treatment is predicated on more than achieving a patient's desired esthetic outcome. Rather, a dentist's treatment objective encompasses providing functionally and physiologically sound, long-lasting esthetic restorations in the context of-and which help to maintain or reestablish-healthy surrounding supporting hard and soft tissues. Any aberrant condition and its etiology must be identified, understood, and corrected to ensure predictable restoration longevity. Therefore, a thorough medical/dental history and clinical examination of the dentition and gingiva (i.e., intraoral and extraoral photographs, radiographs, periodontal probing, etc.) are required. Preoperative impressions and subsequent mounted diagnostic study models also help to establish an accurate diagnosis and initiate treatment planning.
- 3. Presenting well-developed treatment plan options that account for anticipated outcomes and possible complications. Information and records obtained from the comprehensive examination—combined with the patient's completed smile evaluation form, diagnostic wax-up, and utilization of photo manipulation software—enable development of a very accurate representation of possible treatment outcomes. Visualization of anticipated esthetic restorative results is essential for properly planning and logically sequencing treatment. It also facilitates presenting treatment plans to patients, allowing them to determine and discuss whether the proposed procedures and outcomes will fulfill their objectives.

This article demonstrates the manner in which the step-bystep application of these skills, diagnostic information, and communication tools helped to determine and execute the proposed treatment, sequential clinical protocol, and proven restorative modality to meet the needs of a patient presenting with functional wear, spaces between his teeth, and unsightly tetracycline-induced yellow-brown intrinsic staining. The clinical results that were achieved are also discussed.

Case Presentation

A 24-year-old male patient with an obviously high dental IQ presented to the New York University (NYU) College of Dentistry Honors in Aesthetic Dentistry Program, where all treatment is meticulously planned according to the patient's esthetic goals. During the consultation, he stated that his chief complaints were the spacing between his teeth, their yellow discoloration, and wear on his anterior maxillary incisors. He was so tired of the discoloration that he had considered traveling abroad for what he described as "inexpensive" restorative dentistry, which he had learned about on social media. This underscores the lengths patients might go to for treatment but which eventually may affect the long-term predictability of the care delivered.³

	Anterior Te	eth Analysis		Dentofacial Analysis					
Mark any irregularities on the	a diagram for maxillary dentition	Mark any irregularities on the dia	gram for mandibular dentition	Horizontal and Vertical Components					
				Max. Incisal tooth edge in relation to lower lip position during E sound (Smile)					
	AND	1000	T	0 Touching Viet O Slightly covered					
				Lip line - Show of Maxillary Gingival Tissue					
60	()A			0 Normal UCW 0 No ging. HIGH X=23mm ging, seen					
				Dental Midline – Relation to philtrum (or the Facial Midline)					
MAXILLARY TEETH Drawing Checklist:	Axial Inclination	MANDIBUTEETH Drawing Checklist:	Axial Inclination	O Centered O Off to pts. With the pts.					
Facial Contour	Abnormal	Facial Contour	Abnormal	Midline – Canting to right or left (very visible aesthetic problem)					
O Normal	Tooth Spacing O WNL O Crowded	O Normal	Tooth Spacing O WNL Crowded	Normal O To pts.					
Golden Proportion	XDiastemata	Golden Proportion	Ó Diastemata	Display of Max. Anterior Teeth during physiologic rest position (Mmma sound)					
O Normal	Gingival Zeniths	O Normal	Gingival Zeniths	0 0					
Abnormal	X Irregular	Abnormal	V Normal	O Full O Little or no exposure					
Incisal	Gingival Papilla	Incisal	Gingival Papilla	Smile line (maxillary incisal edge relation to superior border of lower lin)					
Embrasures	Normal O Blunted	Embrasures	Normal O Blunted						
O Normal	Gingival Biotype O Thick X Thin	O Normal	Gingival Biotype O Thick X Thin	O Straight O Reverse					
				Number of teeth exposed in a full smile					
				Buccal corridor (bilateral negative space)					
				Normal O Deficie O Full					
NYU College of Dentistry Smile Evaluation Form designed by John Calamia, DMD, Jonathan B. Levine, DMD, Mitchell Lipp, DDS, Mark Wolff DDS, PhD, Sivan Finkel, DMD, Jeffrey McClendon, DM. Adapted from the work of Leonard Abrams DDS, Dr. Mauro Fradeani, DDS, Jonathan B, Levine, DMD									



Figures 1 & 2: Pages 1 and 2 of the NYU College of Dentistry Smile Evaluation Form, which facilitates a patient's objective and subjective evaluation of critical smile components.

A comprehensive clinical examination was performed and requisite records were obtained. Periodontal probing and charting, as well as evaluation of radiographs, revealed a few pocket depths of 4 mm and generalized moderate-to-severe subgingival calculus. Diastemas were present between teeth #8 and #9, #9 and #10, and #11 and #12. His anterior maxillary incisors exhibited wear, and all teeth in the smile zone exhibited orange-yellow discoloration due to tetracycline staining.

When teeth are exposed to antibiotics such as tetracycline, minocycline, or doxycycline that are administered to treat various infections, discoloration and heavy staining of the underlying dentin—which establishes fundamental tooth color more so than enamel—can result.⁴ If taken by pregnant women or children younger than 8 years old, the drug's mechanical properties manifest specific side effects, including binding to the formation of the child's permanent dentition. Upon eruption of the adult dentition, an overpoweringly unesthetic dark brown-gray or yellow band of staining is evident. Treatment outcomes to correct discoloration severity are effected by extent of exposure, age, and weight.⁴

Esthetic Analysis

The smile evaluation form was used when performing the facial analysis. Any esthetic treatment plan is initiated by first examining the facial midline and facial symmetry.² In this case, the maxillary dental midline was deviated approximately 1 mm to the patient's right (Fig 3). Other facial components examined included the interpupillary line and commissural line, which generally should be parallel on a horizontal, incisal plane. The smile line should be convex, curved, and adequately follow the lower lip (Figs 4 & 5).

The patient presented a normal overbite (i.e., 0% to 30%) and overjet (i.e., 1 mm to 2 mm), mild spacing in the maxillary arch, and mild crowding in the mandibular arch (Figs 6 & 7). A low labial frenum attachment was present; this may have been a contributing cause of the diastemas. Teeth ##7-10 showed evidence of incisal wear when the patient was put in lateral excursive movement.



Figure 3: Preoperative full-facial view for analyzing the patient's yellow staining, facial midline, interpupillary line, commissural line, incisal edges, and diastema between #8 and #9.



Figure 4: Preoperative close-up view of the patient's smile line. The anterior maxillary incisal edges should follow the inferior border of the lower lip.



Figure 5: Preoperative retracted view revealing maxillary incisal edge wear.



Figures 6a & 6b: Preoperative retracted left and right lateral views confirming a normal overbite and overjet.



Figures 7a & 7b: Preoperative maxillary and mandibular occlusal views revealing mild spacing in the maxillary arch and mild crowding in the mandibular arch.

Digital Smile Design

To begin applying the principles of golden proportion when designing a beautiful smile, the apparent mesiodistal width of the anterior teeth from distal height of contour to distal height of contour when viewed from the frontal aspect is analyzed first.¹ This assumes a symmetrical relationship among the lateral incisors.

In this case, however, the patient's anterior teeth were measured using a digital caliber, after which the measurements were converted to percentages and compared to golden proportion percentages (Figs 8 & 9).¹ The golden proportion percentages established exact symmetry between the right and left sides, with a newly positioned dental midline coincident to the facial midline.

A digital mock-up, which is faster to produce and comparable to a diagnostic wax-up for patient communication, was then created using photo manipulation software (Adobe Photoshop CS6, Adobe Inc.; San Jose, CA). This allowed visualization of how applying the ideal golden percentages would enhance the patient's smile, prior to fabricating a physical diagnostic wax-up (Fig 10).

Treatment Planning

After the smile evaluation form was completed, study models were made. Because the dental midline is critical to achieving the best esthetic result, a stick bite and facebow transfer (Kois Dento-Facial Analyzer, Panadent; Colton, CA) were taken to register the patient's facial midline, which would subsequently dictate the new dental midline.

The patient's facial midline and incisal plane positions were transferred to the articulated study models, and the incisal plane was made perpendicular to the dental midline.⁵ A diagnostic wax-up that addressed all findings from the smile evaluation form was then completed based on the previously created digital design mock-up (Fig 11). The finalized wax-up would also be used to create vinyl polysiloxane matrixes (e.g., Reprosil, Dentsply Sirona; York, PA) for guiding incisal reduction, buccal reduction, and fabricating bis-acryl provisional restorations (Luxatemp B1 Ultra, DMG America; Ridgefield Park, NJ).



13.2% 17.1% 21.1% 21.1% 15.8% 11.8%

Patient Percentage Breakdown

Golden Ratio	0.618	1.0	1.618	1.618	1.0	0.618
Patient Ratio	0.8515	1.107	1.362	1.362	1.021	0.7664

Figure 8: The patient's anterior tooth measurements were converted to percentages.



Figure 9: The patient's percentages were then compared to golden proportion percentages.

Figure 10: The digital mock-up demonstrated how the patient's smile would be enhanced by applying the ideal golden percentages, creating exact symmetry between the right and left sides with a newly positioned dental midline coincident to the facial midline.



Figures 11a & 11b: Maxillary and mandibular wax-ups were created to address all findings from the smile evaluation form.



Figure 12: The maxillary teeth could be conservatively and minimally prepared, since the patient's tetracycline staining was not severe.



Figure 13: Maxillary and mandibular provisional restorations were placed and the frenectomy and gingival zenith recontouring completed using a diode laser.

The treatment plan developed and presented to the patient included:

- 1. scaling and root planing in four quadrants to first address the patient's periodontal issues prior to undertaking esthetic restorative procedures
- 2. orthodontic treatment to close the diastemas, correct the midline, and establish proper space distribution
- 3. tooth whitening
- 4. diode laser frenectomy and gingival zenith recontouring
- preparation of teeth ##4-13 and ##20-29 for feldspathic porcelain veneers to address esthetic and functional concerns, as well as provide the most natural esthetic and functional occlusion based on establishing proper canine guidance
- 6. occlusal guards for preventive treatment.

However, because long-term tooth whitening and orthodontic movement would not completely satisfy the patient's requirements for convenient, less time-consuming, and predictable color stability, he declined these treatment components.

Preparation and Provisionalization

A fundamental objective when performing restorative dentistry is conserving sound tooth structure.⁶ In this case, because the pa-

tient's tetracycline staining was not severe (i.e., it did not present as blue-gray or black accompanied by significant banding across the tooth), minimal preparation was required to enable sufficient masking (Fig 12).⁷ Therefore, the maxillary and mandibular teeth were prepared through the reduction matrix using a 0.5-mm depth-cutting bur, and a chamfer line was placed in enamel. Due to the preparation depth, the dentin layer was not reached; as a result, the darker orange-yellow staining that otherwise could have altered the desired final shade did not emerge.

The incisal edges were reduced 1.5 mm to allow abundant space for establishing restoration translucency,⁸ and maxillary interproximal contacts were not preserved since tooth shape, width, and contour would be altered. The preparation shade was documented and recorded with photographs, after which impressions were taken using heavy and light body vinyl polysiloxane material (Aquasil Ultra, Dentsply Sirona).

Using the matrix created from the wax-up, maxillary and mandibular provisional restorations in shade B1 were fabricated and placed (Luxatemp; Luxaflow), and the frenectomy and gingival zenith recontouring were accomplished utilizing a diode laser (Fig 13). Impressions of the provisional restorations were then taken and forwarded to the laboratory for fabricating the feldspathic porcelain veneers.



Figure 14a: Postoperative retracted smile.



Figure 14b: Postoperative retracted smile highlighting the restored incisal edges.



Figure 14c: Postoperative maxillary view.



Figure 14d: Postoperative mandibular view.



Figure 14e: Postoperative left lateral view.



Figure 14f: Postoperative right lateral view.



Figure 14g: Postoperative portrait, smile view.

Delivery

After the feldspathic porcelain veneers arrived from the laboratory, their contour, fit, and shade were evaluated on study casts. The provisionals were removed carefully to prevent damaging tooth structure, and the preparations were cleaned, rinsed, and dried.

The veneers were first tried in with water, enabling the patient to approve their appearance and initial fit prior to definitive cementation. More importantly, this provided an opportunity to determine whether the tetracycline staining affected the final veneer shade (i.e., potentially make them appear darker). Fortunately, due to the conservative nature of the preparations, the minimal staining did not require the use of an opaque shade of luting resin. Therefore, a translucent shade of luting resin (Choice 2, Bisco; Schaumburg, IL), which would produce a more natural and organic color, was selected for cementation.

The veneers were removed from the mouth, cleaned of contaminants using distilled water, and dried with air. A two-part porcelain primer (Bis-Silane Parts A and B, Bisco) was applied to the internal surfaces, after which a layer of bonding agent was applied. The preparations were etched for 20 seconds using a 35% phosphoric acid solution (Ultradent Products; South Jordan, UT), rinsed with water, and dried with air. A bonding agent (Porcelain Bonding Resin, Bisco) was applied to the preparations, lightly air-thinned, and light-cured.

Luting resin was injected evenly over the bonding surface of the veneers, which were then seated onto the teeth and held in place with light finger pressure. A fine-tip soft brush was utilized to remove excess luting material that had extruded from the margins, and the veneers were tack-cured at the gingival margins for 3 seconds (Valo curing light, Ultradent). Any remaining excess cement was removed with interproximal flossing toward the lingual. The restorations were then thoroughly light-cured for 45 seconds.

Occlusion, proximal contact relationships, marginal integrity, and gingival margin health were evaluated and adjusted as needed (Figs 14a-14g).

Summary

Although tetracycline staining varies in severity, proper planning can enable execution of the most appropriate restorative treatment, preservation of healthy tooth structure, and simultaneous removal and/or masking of discoloration. A detailed and comprehensive treatment plan is significant for achieving successful esthetic restorative outcomes and provides a valuable and efficient roadmap toward exceeding patient expectations. In this case, such planning enabled a minimally invasive approach incorporating feldspathic porcelain veneers that ultimately satisfied the patient's requirements for establishing functional occlusion (i.e., improved axial inclinations that approximate the ideal). However, these results are only possible with collaboration and appropriate communication among all parties—laboratory, patient, and dentist.

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Dr. Finkelstein is a postgraduate dental general practice resident at Coney Island Hospital, Brooklyn, New York.



Dr. Calamia is a professor in the Department of Cariology and Comprehensive Care at NYU College of Dentistry, New York, New York.

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