

CORRECTING Anterior Crowding

Using Orthodontic Therapy & Conservative Esthetic Treatment: A Case Report



After reading this article, the participant should be able to:

1. Understand management of anterior crowding utilizing the Invisalign system, followed by conservative esthetic restorations.
2. Know the principles of ideal smile design and smile analysis to identify esthetic violations of a patient's smile.
3. Have an appreciation for effective communication with the dental laboratory to achieve a successful treatment outcome in similar cases.

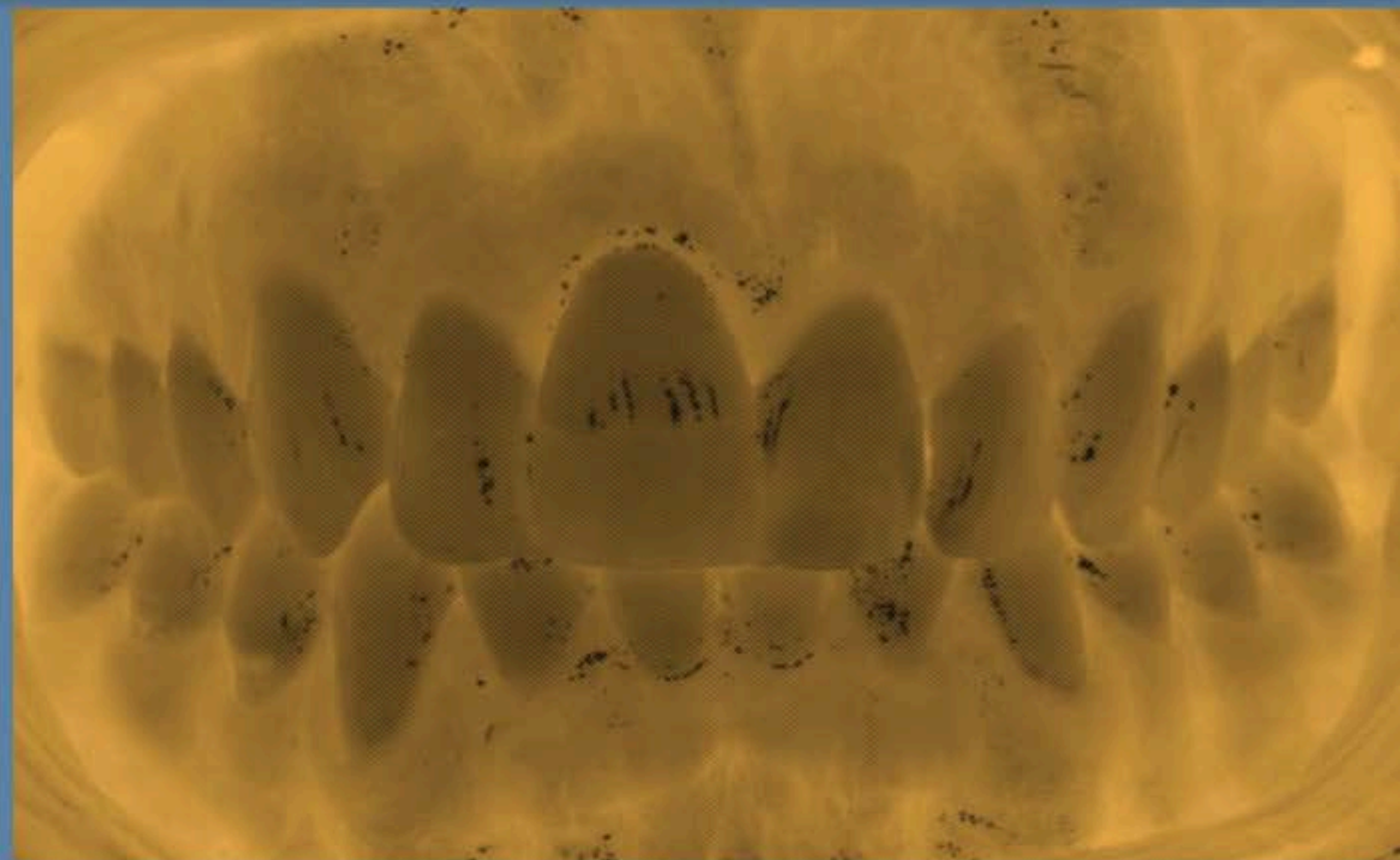
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Abstract

Anterior crowding is one of the more challenging cosmetic clinical situations. Esthetic enhancement of such cases may involve orthodontics, veneers, both, or full-mouth rehabilitation with crowns.

Adult patients seeking orthodontic treatment are increasingly motivated by esthetic considerations. Most of these patients reject wearing labial fixed appliances; rather, they are seeking more esthetic treatment options, including lingual orthodontics and Invisalign appliances. This article discusses a smile design case to treat a crowded anterior dentition using the Invisalign appliance, followed by feldspathic porcelain veneers and a zirconia crown restoring the maxillary anterior teeth.

Key Words: anterior crowding, smile analysis, esthetic design, Invisalign system, indirect porcelain veneers



Introduction

Many adult patients who desire cosmetic enhancement of their crowded dentition do not want traditional braces.^{1,2} The Invisalign system (Align Technology; Santa Clara, CA) is a technologically advanced esthetic approach to treating malocclusion, which offers an alternative for these patients,^{1,2} who are reluctant to accept orthodontic treatment.

Invisalign uses three-dimensional computer-imaging technology to create clear plastic trays that can move teeth.^{3,5} A series of practically undetectable aligners are changed every two weeks to achieve the desired results. Invisalign can also be a useful tool for limited movement of teeth/root positions to set up esthetic restorative treatment.⁶

Treatment Options for Correcting Anterior Crowding

From a cosmetic standpoint, if orthodontically straightening and bleaching the teeth can meet the patient's expectations, then orthodontics should be considered. However, if the teeth need to be lengthened or the sizes of the teeth do not match, then veneers are required to correct the tooth shape discrepancies even if orthodontic therapy is completed. In many cases, combining orthodontics with veneers provides a conservative esthetic outcome by avoiding aggressive tooth preparation if veneers are to be used alone.⁷

From a functional standpoint, the patient's occlusion may be managed with orthodontics or restorative options that are either veneers or full-mouth rehabilitation with crowns.

Using the Invisalign system, crowding can be corrected by dental expansion, which can be accomplished in several ways. One method is that all the teeth move at the same time; expansion occurs as teeth move to eliminate the crowding. In another method, the first premolars through second molars expand first. When space appears distal to the canines, the canines move distally, creating space anteriorly, which can then be used to correct crowding in the incisor region.⁸

According to Boyd and colleagues, a candidate for treatment with Invisalign should have fully erupted permanent teeth; growth should have minimal or no effect on treatment.⁹

“Many adult patients who desire cosmetic enhancement of their crowded dentition do not want traditional braces.”

Occlusal problems that are correctable with Invisalign include mild spacing (1 to 3 mm), moderate spacing (4 to 6 mm), mild crowding (1 to 3 mm), moderate crowding (4 to 6 mm), and narrow arches that are dental in origin (4 to 6 mm). Patients who have relapsed following conventional orthodontic treatment also may benefit. Such treatment decreases the time that the patient is in fixed appliances.⁸

Smile Analysis and Esthetic Design

Rufenacht classified smile analysis into facial esthetics, dentofacial esthetics, and dental esthetics.¹⁰ Dental and facial esthetics have been defined in terms of macro and micro elements. Macroesthetics includes the interrelationships between the face, lips, gingivae, and teeth, and the perception that these relationships are pleasing. Microesthetics involves the esthetics of an individual tooth and the perception that the color and form are pleasing.¹¹ Further classification identifies five levels of esthetics: facial, oral-facial, oral, dentogingival, and dental.^{12,13}

At the macro level, facial elements and thirds are evaluated for form and balance, with an emphasis on how they may be affected by dental treatment.^{13,14}

Midline placement is related to normal gingival form and is thus evaluated as part of dentogingival esthetics design. When considering modifying the midline to create an esthetic smile design, the following rules can be applied:¹²

- The midline only should be moved to establish an esthetic intra- and inter-tooth relationship, with the two central incisors being most important.
- The midline only should be moved restoratively up to the root of the adjacent tooth.
- If the midline is within 4 mm of the center of the face, it will not be esthetically displeasing.
- The midline should be vertical when the head is in the postural rest position.

Dental esthetics evaluation involves choosing tooth shapes for patients based upon their facial characteristics and determining the length of teeth for establishing an esthetic width-to-length ratio.

Case Study

A 34-year-old male patient presented for cosmetic treatment (Fig 1). His main concern was maxillary and mandibular anterior crowding. The patient was also unhappy that the length and shape of his maxillary central incisors did not match each other. Tooth #8 had an old cracked porcelain veneer and was in labioversion and almost in the midline, resulting in a displeasing smile. He wanted to have a symmetrical, uniform, attractive smile.

Clinical Examination

To evaluate the patient's smile as well as the orthodontic and restorative treatment options, a comprehensive examination was performed, which included full-mouth radiographs, hard and soft tissue charting, and mounted diagnostic models and photographs. Clinical examination revealed that the patient had a cracked porcelain veneer on #8, few carious posterior teeth, and periodontitis that required scaling and root-planing prior to commencing treatment. The tissue heights of incisors were uneven, resulting in the appearance of disproportional teeth sizes. His temporomandibular joint was asymptomatic and there were no audible or palpable joint noises.

After analyzing the patient's study models, careful consideration was given to the midline and the smile design to achieve a symmetrical result.

Diagnosis

The patient's smile was not esthetically pleasing and violated a number of principles of the ideal smile design (Fig 1), as follows:

- labioversion of maxillary right central incisor
- overlapping of #7 and #9, the latter being mesially drifted
- canted and shifted midline to the patient's right
- canted axial inclination of maxillary incisors and canted incisal plane (Fig 2)
- discrepancy in shape and size of incisors
- too-pointed, aggressive-looking canines
- reverse smile line
- narrow buccal corridor
- uneven gingival architecture of maxillary incisors (Fig 3)
- deep bite.



Figure 1: Pretreatment; retracted frontal 1:2 view. The patient could not smile fully because he was self-conscious about his displeasing smile.



Figure 2: Pretreatment; axial inclination of maxillary anterior teeth.



Figure 3: Pretreatment; asymmetrical gingival heights of maxillary anterior teeth.

Treatment Plan

The treatment plan presented the following recommendations:

- periodontal treatment (scaling and root-planing)
- diagnostic preoperative models were presented to the patient, along with a drawn smile analysis to assist in determining the options and course of treatment
- Invisalign appliance to achieve the following treatment goals:
 - correct crowding of the maxillary incisors by expansion of both maxillary and mandibular arches and interproximal reductions (IPRs) of anterior teeth
 - align upper midline to lower midline by moving maxillary midline to the patient's right with IPR
 - correct deep bite by intruding lower anterior incisors if needed, while maintaining anterior guidance and cuspid rise
 - expand the arch in the premolar region for a more esthetic buccal corridor
 - extrude #8 to match ideal cervical gingival level of #9, and the excess tooth length would be filed as needed
- gingival margin recontouring for ##9-11 to match that of their right contralaterals using a Biolase laser (Biolase Technology, San Clemente, CA)
- bleaching
- restorative therapy, to replace the old porcelain veneer on #8 with zirconia crown; and fabricate porcelain veneers for #6 and #7 and ##9-11 to change the shape, size and color of the teeth for a more esthetic smile.

Smile Design

Establishing Location of the Incisal Edge

One of the most important factors for a successful esthetic outcome is locating the position of the incisal edge, as determined by occlusion, phonetics, and esthetics. The degree of lip movement is an important factor in determining location of the incisal edge; the less the lip moves during a smile, the more tooth will have to show at rest to achieve enough tooth display when smiling. Ideally, this is to show the free gingival margin of the centrals, which are 9.5 to 11 mm.¹⁵

A gradual decrease in maxillary incisor exposure was reported for each increase in age group from under 30 to over 60, where the mean tooth exposure of the maxillary central incisor reported among the 30- to 40-year-old age group was 1.6 mm.¹⁶

The results of a study conducted by Misch¹⁷ revealed that there was a large range of maxillary central incisal exposure in relation to the maxillary lip line, whereas the range of canine exposure was narrower for the different gender and age groups. Accordingly, it was suggested that the average canine exposure dimension could be used clinically to assess anterior incisor edge position.

In an esthetic smile, it is ideal to have no more than 2 mm of gingiva showing when the patient is in full smile,¹⁸ and the incisal line comes very close to and almost touches the lower lip, being no more than 2 mm away.¹⁰

In this case, the patient presented with 6 to 7mm maxillary central display at rest, and more than 2 mm between the incisal line and the lower lip with a reverse smile line. As for the amount of gingival display, #9 showed an ideal amount of display; however, #8 displayed none (-2 mm). The canines' exposure was used to establish the position of the incisal edge to avoid an aged-looking smile, if the average incisors maxillary central incisal exposure was used instead.¹⁷

Establishing Length and Tissue Heights of the Central Incisors

After locating the incisal edge position, the length and tissue heights of the central incisors were established. A trace drawing of a retracted straight-on photograph was used to apply design concepts. The tracing showed where the tissue and teeth needed to be placed for the end result, and thus helped to define the treatment plan.

Using tracing paper, the patient's teeth were outlined. The new incisal edge position and the gingival position were then placed on the working outline (Fig 4).

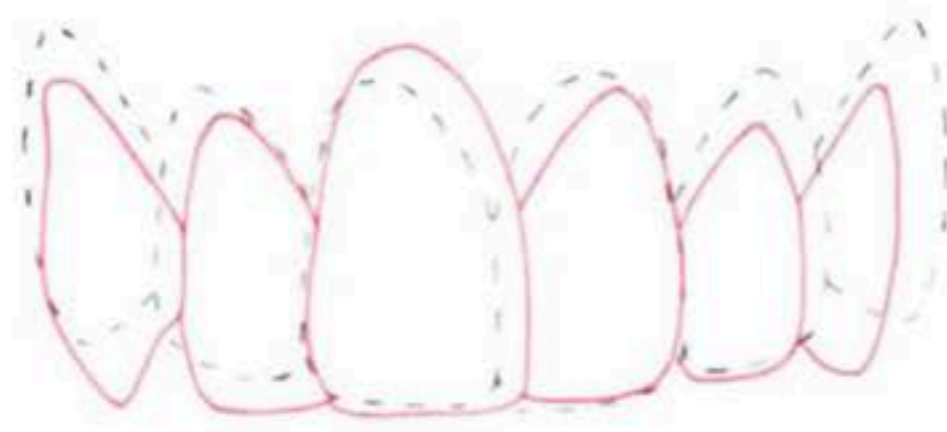


Figure 4: Preoperative tracing of anterior teeth with superimposed tracing of diagnostic wax-up.

Treatment

Initial Data

After a clinical examination was conducted and the necessary diagnostic records were gathered, the patient's malocclusion was diagnosed. It was determined that the patient was a candidate for the Invisalign system. Polyvinyl siloxane (PVS) (ESPE America, Norristown, PA) impressions of the patient's teeth, along with a bite registration, copies of the full-mouth radiographs, and intraoral and extraoral photographs were sent to Align Technology. PVS was the material of choice because it yields highly accurate impressions that remain stable for as long as three weeks and allows for multiple pours.⁹ The recommended protocol is a two-step technique. An Invisalign treatment-planning form (i.e., prescription) was prepared to specify the goals of treatment and to suggest the specific path of tooth movements required to achieve the desired corrections. At the company, scan models were derived from the PVS impression; these were used to produce the three-dimensional computer models that later were manipulated for simulated tooth movement and ultimately used as the basis for the production of a series of aligners. The number of intermediate stages (and thus the number of aligners) between the original malocclusion and the final treatment result is governed by the path of tooth movement and the velocity at which the teeth are to be moved.

In about half of treatment protocols, it is necessary to add one or more attachments to the teeth; these are simply "buttons" of restorative composite (Herculite, Kerr; Orange CA) or light-cure bonding material. The attachments provide undercuts that facilitate tooth movement. In some instances, they may be used for the retention of the aligners in patients with short clinical crowns.

In many patients with minor to moderate crowding undergoing Invisalign orthodontic appliance treatment, IPR is part of the patient's treatment plan.

Invisalign treatment time was about 10 months using one set of maxillary and lower aligners.¹⁹ After orthodontic therapy was completed, a new smile analysis was performed as before. There was a significant improvement in teeth alignment, smile line, and buccal corridor (Fig 5). However, the patient's smile was



Figure 5: Post-orthodontic treatment; retracted frontal view. Note the improved smile line and corrected crowding of teeth.

Smile Design Assessment

An Ideal Esthetic Smile

No more than 2 mm of gingiva should show when the patient is in full smile, and the incisal line should come very close to and almost touch the lower lip, being no more than 2 mm away.

This Case

The patient presented with 6 to 7 mm maxillary central display at rest, and more than 2 mm between the incisal line and the lower lip with a reverse smile line. As for the amount of gingival display, #9 showed an ideal amount of display; however, #8 displayed none (-2 mm).

still esthetically unpleasing. To achieve the youthful, uniform smile the patient desired, a clinical mock-up was completed and the proposed new size of incisors and new shape of canines (more rounded) were evaluated for esthetics, phonetics, and occlusion. After the patient's approval, it was determined that the patient's esthetic needs could be satisfied by restoring #8 with a zirconia crown and #6, #7, and ## 9-11 with porcelain laminate veneers to correct the remaining esthetic issues (Figs 6 & 7):

- canted midline
- discrepancy in shape, length, and width between #8 and #9, and between #7 and #10
- asymmetrical gingival level between #6 and #7, and between #10 and #11
- sharp, aggressive-looking canines.

Preparation

At the preparation appointment, before preparing the teeth, the gingival zenith of ##9-11 was raised slightly to be symmetrical with their contralaterals, using a Bi-lase laser. The crestal bone was sounded and found to be 3.5 mm from the free gingival margin.¹⁹

The existing veneer was removed from #8 and was prepared for a full-coverage zirconia crown. Preparation for veneers on #6, #7, and ##9-11 was done guided by reduction templates to ensure proper tooth reduction. The preparations extended 0.5 mm subgingival and the lingual margins were placed at the incisal marginal ridge for maximum strength of the tooth and the restoration. Lingual margins should not be placed in the lingual fossa, which is the area with the highest concentration of stress on the entire tooth.^{20,21} The teeth were prepared in such a way as to give the laboratory 2 mm of incisal and 1.5 mm of facial room to develop subtle internal characterizations with the porcelain. The gingival proximal area extended lingually at the crest of the papilla, to provide adequate porcelain to eliminate black triangles. Final impressions were taken and provisional restorations were made. The occlusion was adjusted and an alginate impression of the provisional restorations was taken and poured in stone, to be sent to the laboratory (Figs 8-11). Photographs of the provisionals and the patient's face with the provisionals were taken for better communication with the laboratory. A few days later, the patient came in for a postoperative check of his provisionals, and bleaching was done at the same appointment.

Stump shades were chosen a few days after bleaching, and photographs were taken of the preparations with stump guides in view for the laboratory's use (Fig 12).



Figure 6: Post-orthodontic treatment; axial inclination of maxillary anterior teeth. Note the canted midline and discrepancy in size and shape between #8 and #9, as well as between #7 and #10.



Figure 7: Post-orthodontic treatment; gingival heights of maxillary anterior teeth.



Figure 8: Model of the provisional was made to communicate with the laboratory.



Figure 9: Frontal view (open) of provisional model to check embrasures.



Figure 10: Frontal view (closed) of provisional model to check length of restorations compared to the provisionals.

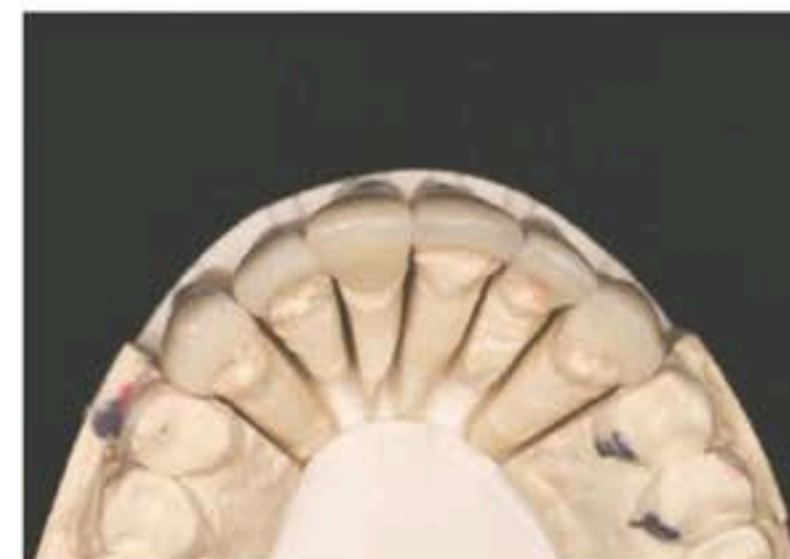


Figure 11: Occlusal view of provisional model to check incisal embrasures, lobing, and anatomy.



Figure 12: Shade tab 1M1.

Laboratory Communication

A detailed prescription was sent to the laboratory, along with the mock-up and a smile analysis. Also sent was a full series of 35-mm digital photographs showing the following:

- 12 preoperative views recommended by the AACD
- preparations for stump shading
- stickbite for proper establishment of midline and horizontal plane
- Face and full smile with the provisional restorations seated in the mouth.

Models of the provisionals, along with the bite records, original facebow-mounted casts, and a bite fork of the prepared maxillary teeth and shade-mapping instructions were sent to the laboratory. Progressive shades were selected to blend with the patient's natural teeth.

The challenge in this case was to match the #8 zirconia crown with feldspathic porcelain veneers on #6 and #7, and ##9-11. CZR porcelain (Kuraray Noritake Dental; Tokyo, Japan) was used to achieve the same type of light refraction throughout the whole anterior zone. A subtle gradation of color was applied not only from gingival to incisal for a polychromatic effect, but also a gradation of color from centrals to canines to create a natural progression of color to blend into the buccal corridor. We started with a 1M1 Vita 3D shade (Vident; Brea, CA) on the centrals and blended to a 1M1 incisal 1M2 gingival toward the canines. Along with subtle microesthetic characterizations in the form of slight striations and bamboo halo effect at the incisal edge, an appearance of added depth and life was incorporated into the restorations. A moderate surface texture was also applied to break up light and cause a definite glare pattern, adding to the realism of the restorations. To avoid over-glazing a hand polish was applied, so that when the restorations are presented with natural moisture all the internal and external features would provide a more realistic and vibrant outcome.

Seating Appointment

Two weeks after the preparation appointment, the patient was seen to seat the restorations. Each veneer was checked individually on the teeth; they then were checked again on the prepared teeth as a group. Interproximal contacts were checked and adjusted as needed. The patient was very pleased and he approved them for final cementation (Figs 13 & 14). The veneers were seated, cured, and finished one at a time, except for the zirconia crown for #8 and veneer for #9, which were seated together in order to control the midline. Teeth #7, #10, #6, and #11 were seated in that order. When #7 was seated, #6 was held in position without cement to ensure proper seating of #7; this same procedure was followed for the remaining teeth.

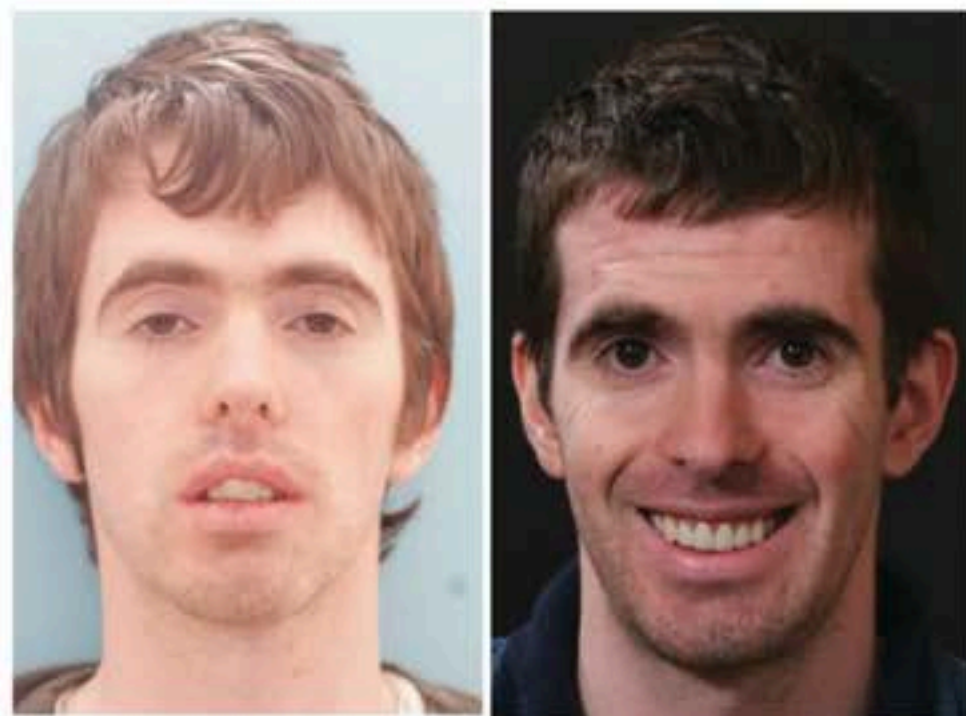
Pre- and post-treatment facial and full-smile views (Figs 15a-17b) show good alignment of the anterior teeth and symmetry of the midline; a pleasing smile line following the patient's lower lip; symmetrical right and left centrals, laterals, and canines; and ideal gum level of maxillary anterior teeth. The right value and maverick colors were selected to match the patient's natural dentition, resulting in seamless, natural-looking restorations.



Figure 13: Post-restorative treatment; retracted frontal 1:2 view. Final restorations with even gingival architecture, and symmetrically shaped and sized centrals.



Figure 14: Post-restorative treatment; gingival heights of maxillary anterior teeth.



Figures 15a & 15b: Pretreatment; full face, 1:10. The patient's smile was not esthetically pleasing and violated a number of ideal smile design principles. Post-treatment; 1:10—an attractive, rejuvenated face due to the improved smile design.

“ Using the Invisalign system, crowding can be corrected by dental expansion, which can be accomplished in several ways. ”



Figure 16a: Pretreatment; the patient's reluctant attempt to smile.



Figure 16b: Post-orthodontic treatment; full smile, 1:2. Note the good alignment of maxillary anterior teeth after using the Invisalign appliance.



Figure 16c: Post-restorative treatment; full smile, 1:2. Completed treatment reflects a more symmetrical and pleasing smile.



Figure 17a: Pretreatment; maxillary occlusal 1:2 view. Note the labioversion of #8 and crowding of anterior teeth.



Figure 17b: Post-treatment; maxillary occlusal 1:2 view. Note the good alignment of teeth.

Summary

The Invisalign system provides new opportunities to treat adult patients who otherwise would not consider conventional orthodontic treatment. In this case, because the treatment plan involved orthodontics, both esthetic and occlusion results were enhanced. Also, the veneer preparations in this case were very conservative since the teeth were aligned into the proper position. The patient was very pleased with the final results.

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References

- Nedweed V, Miethke RR. Motivation, acceptance and problems of Invisalign patients. *J Orofac Orthop*. 2005 Mar;6(2):162-73.
- Meier B, Wiemer KB, Miethke RR. Invisalign—patient profiling. Analysis of a prospective survey. *J Orofac Orthop*. 2003 Sep;64(5):352-8.
- Vlaskalic V, Boyd RL. Clinical evolution of the Invisalign appliance. *J Calif Dent Assoc*. 2002 Oct;30(10):769-76.
- Chenin DA, Trosien AH, Fong PE, Miller RA, Lee RS. Orthodontic treatment with a series of removable appliances. *J Am Dent Assoc*. 2003 Sep;134(9):1232-9.
- Miller RJ, Derakhshan M. Three-dimensional technology improves the range of orthodontic treatment with esthetic and removable aligners. *World J Orthod*. 2004 Fall;5(3):242-9.
- Javaheri DS. Using technological advances to treat the crowded anterior dentition. *J Cosmetic Dent*. 2006 Summer;22(2):79-86.
- Javaheri DS. Orthodontics, veneers, or both. Treatment planning the crowded anterior dentition. *Dent Today*. 2003 Jun;22(6):78-82.
- McNamara JA, Brundon WL, Kokich VG. Orthodontics and dentofacial orthopedics. Ann Arbor (MI): Needham Press; 2001. p. 475-86.
- Boyd RL, Miller RJ, Vlaskalic V. The Invisalign System in adult orthodontics: mild crowding and space closure cases. *J Clin Orthod*. 2000;34(4):203-12.
- Rufenacht CR. Principles of esthetic integration. Hanover Park (IL): Quintessence Pub; 2000.
- McLaren EA, Culp L. Digital smile design and prototypes: the Photoshop® smile design technique: part I. *J Cosmetic Dent*. 2013 Spring;29(1):94-108.
- McLaren EA, Tran Cao P. Smile analysis and esthetic design: "in the zone." *Inside Dent*. 2009 Jul-Aug;5(7):46-8.
- McLaren EA, Rifkin R. Macroesthetics: facial and dentofacial analysis. *J Calif Dent Assoc*. 2002 Nov;30(11):839-46.
- Morley J, Eubank J. Macroesthetic elements of smile design. *J Am Dent Assoc*. 2001 Jan;132(1):39-45.
- Spear F. The maxillary central incisal edge: a key to esthetic and functional treatment planning. *Compend Contin Educ Dent*. 1999 Jun;20(6):512-6.
- Vig RG, Brundo GC. The kinetics of anterior tooth display. *J Prosthet Dent*. 1978 May;39(5):502-4.
- Misch CE. Guidelines for maxillary incisal edge position—a pilot study: the key is the canine. *J Prosthodont*. 2008 Feb;17(2):130-4.
- Kokich VO, Kiyak HA, Shapiro PA. Comparing the perception of dentists and lay people to altered dental esthetics. *J Esthet Dent*. 1999;11(6):311-24.
- Tamow D, 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 Dec;63(12):995-6.
- Castelnuovo J, Tjan AH, Phillips K, Nicholls JJ, Kois JC. Fracture load and mode of failure of ceramic veneers with different preparations. *J Prosthet Dent*. 2000 Feb;83(2):171-80.
- Magne P, Versluis A, Douglas WH. Rationalization of incisor shape: experimental-numerical analysis. *J Prosthet Dent*. 1999 Mar;81(3):345-55. **JCD**

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