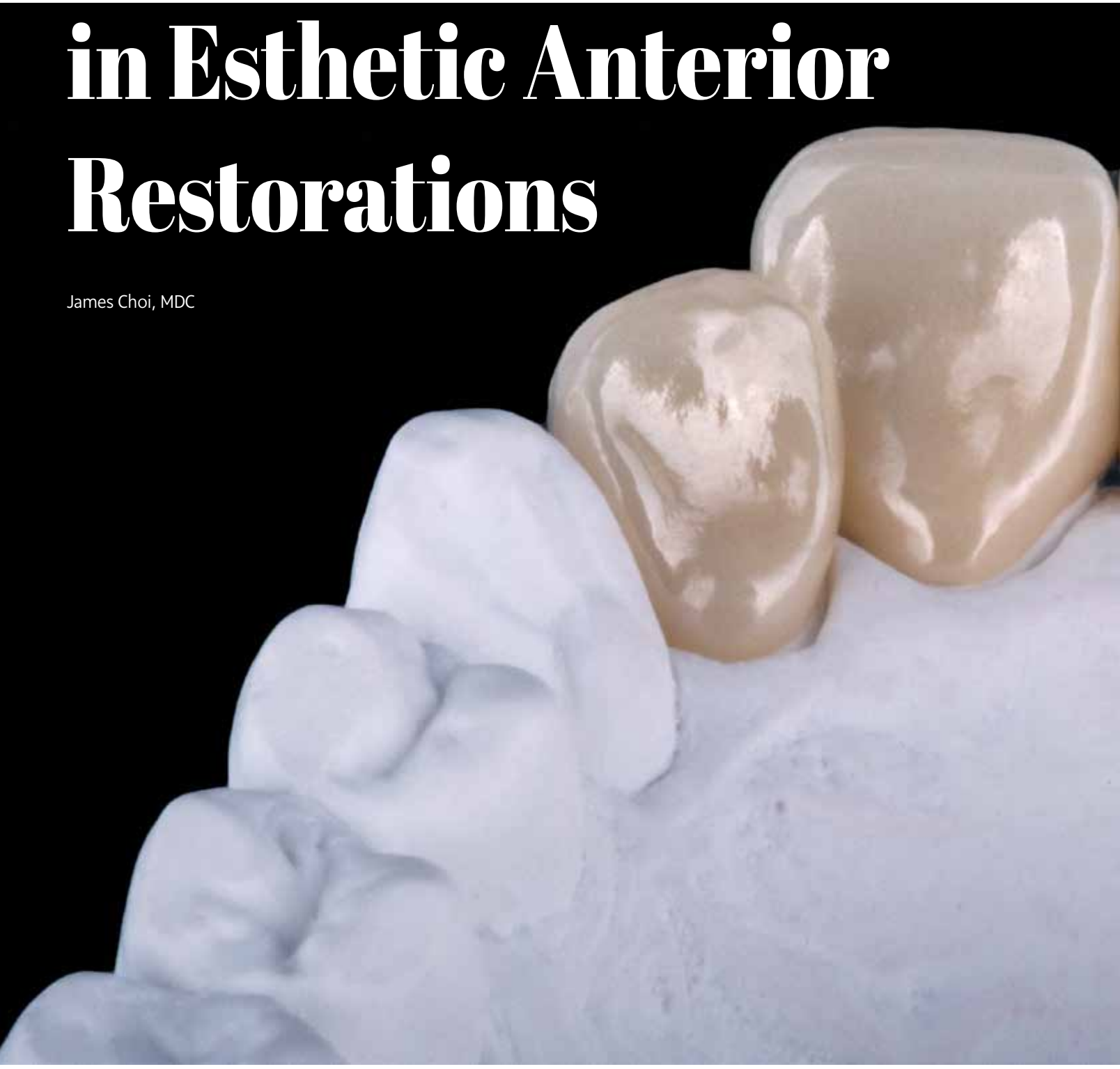
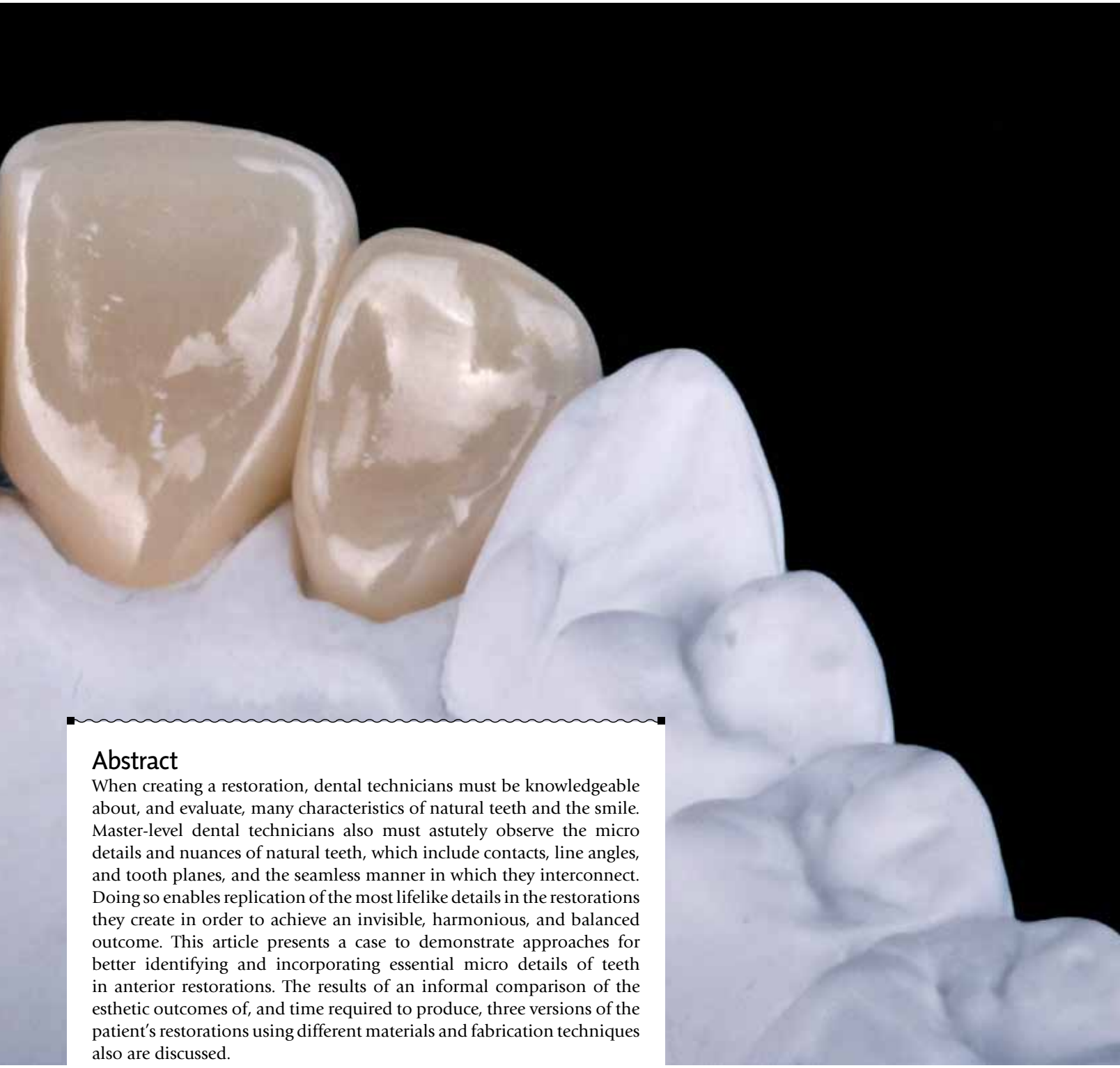
Imparting Micro Details in Esthetic Anterior Restorations

James Choi, MDC





Abstract

When creating a restoration, dental technicians must be knowledgeable about, and evaluate, many characteristics of natural teeth and the smile. Master-level dental technicians also must astutely observe the micro details and nuances of natural teeth, which include contacts, line angles, and tooth planes, and the seamless manner in which they interconnect. Doing so enables replication of the most lifelike details in the restorations they create in order to achieve an invisible, harmonious, and balanced outcome. This article presents a case to demonstrate approaches for better identifying and incorporating essential micro details of teeth in anterior restorations. The results of an informal comparison of the esthetic outcomes of, and time required to produce, three versions of the patient's restorations using different materials and fabrication techniques also are discussed.

Key Words: micro detail, line angles, contact points, tooth planes

Introduction

An important criterion for successful esthetic restorations is their ability to integrate and harmonize within the surrounding oral hard and soft tissues, in addition to satisfying the fundamental requirements of proper fit and occlusion.[1] Therefore, when creating a restoration, dental technicians must be knowledgeable about, and evaluate, many characteristics of natural teeth and the smile. These include the surrounding gingival architecture, clinical crown size, tooth alignment, balance among multiple teeth, tooth contacts, line angles and planes, and occlusion. The purpose of evaluating these tooth and smile components is to properly understand and reproduce their respective nuances to achieve a balanced and harmonious restoration.

Fortunately, a variety of books and articles provide valuable information about methods to establish tooth size and form when creating restorations[2-6] Some guidelines (e.g., golden proportion, recurring esthetic dental (RED) proportion) rely on mathematical formulas to achieve harmonious restorations in the anterior region.[7] However, tooth size and shape vary depending on a person's race, region, gender, and dietary habits,[8] and individual patients should not be standardized in the same mathematical way.

Although formulating tooth size and the ideal gingival architecture is very useful in prosthodontics, there are limitations in achieving optimal results that cannot be justified mathematically. Therefore, although dentists and dental technicians should follow fundamental guidelines during esthetic treatment planning, they should acknowledge that esthetics vary greatly from person to person.[9] This necessitates consideration of each individual patient and their various natural teeth proportions during restoration and/or replacement of maxillary anterior teeth.[7-11]

It also requires master-level dental technicians to astutely observe the micro details and nuances of natural teeth in order to replicate them in restorations and achieve an invisible, harmonious, and balanced outcome. Such details include contacts, line angles, and tooth planes, and the manner in which these entities seamlessly interconnect.

Whether the restoration is fabricated purely by hand or with the aid of CAD/CAM technology, technicians must determine and carefully execute the creation of micro details to impart lifelike characteristics into anterior restorations. Not only does this involve evaluation and selection of appropriate materials and the translucency/opacity of ceramics, but they must also undertake the requisite and time-consuming fabrication, layering, and finishing steps to achieve the desired esthetic results.

Using the following case presentation as a point of reference, this article identifies essential micro details of teeth and describes approaches that can be utilized to better observe and replicate them in anterior restorations. By achieving balance in the final restorations—beginning with a single tooth and proceeding to multiple restorations in the esthetic zone, whether a bridge or multiple units—balance that closely approximates the form and angles of natural teeth can be created. Further, the results of an informal comparison of the esthetic outcomes of, and time required to produce, three versions of the patient's restorations using different materials and fabrication techniques are presented.

Case Presentation

A male in his mid-40s presented with the chief complaint of being unable to properly pronounce certain words due to the flat lingual anatomy of his existing restorations. The patient, who had been dissatisfied with the previous restorations for the approximately five years since they were delivered, brought with him the original pretreatment model of his arch **(Figs 1 & 2)**.

A former hockey player, the patient expressed high expectations and extremely specific requirements for the dental team to address. In particular, he wanted his palatal anatomy returned to its pre- first restoration state, as well as improved esthetics. The latter request would require lengthening the four anterior restorations to create balance with the remaining dentition in the esthetic region.

Esthetic Analysis

The dental team, including the dentist and the technician, analyzed the patient's existing restorations and original model, particularly focusing on all angles that would create harmony and balance in the esthetic zone **(Fig 3)**. Emphasis was placed on the micro details in the triangular contact zone (i.e., proximal transitional surfaces),[1] including the gingival architecture and how contact design interconnected with restoration form **(Fig 4)**. In particular, critical factors that were observed included contact points, multiple angles of crest formations that would be imparted into the restorations, and tooth planes, as well as how all three would individually and collectively contribute to replicating natural tooth formations.

A mountain can be used as an analogy in describing the interplay of contact points, line angles, and planes in tooth formations. Mountains have ridges and slopes that form valleys. Similarly, individual teeth exhibit different angles of elevated crests and plane distributions (e.g., labial or lingual grooves) that are all interconnected; there is never a rogue groove or lobe that is not connected to a plane or crest.[1]

Based on this evaluation, as well as the patient's excellent gingival health, soft tissue contours **(Fig 5)**, and provisional restoration **(Fig 6)**, a diagnostic wax-up was created to propose the ideal length, width, and shape of the new restorations to satisfy everyone involved in the case. Because the patient's gingival tissues were ideal, the dental technician could accurately replicate and control the recreation of contact locations in the final restorations based on the provisional restoration.

In fact, based on the provisional restorations, the diagnostic wax-up approximated 90% of the desired final restorative outcome (e.g., shade, midline placement, restoration height and width, individual tooth contact locations). The remaining 10% encompassed the micro details and subtle nuances that are the hallmarks of truly lifelike and "invisible" esthetic restorations.

Figure 1: Labial view of the patient's original pretreatment model.

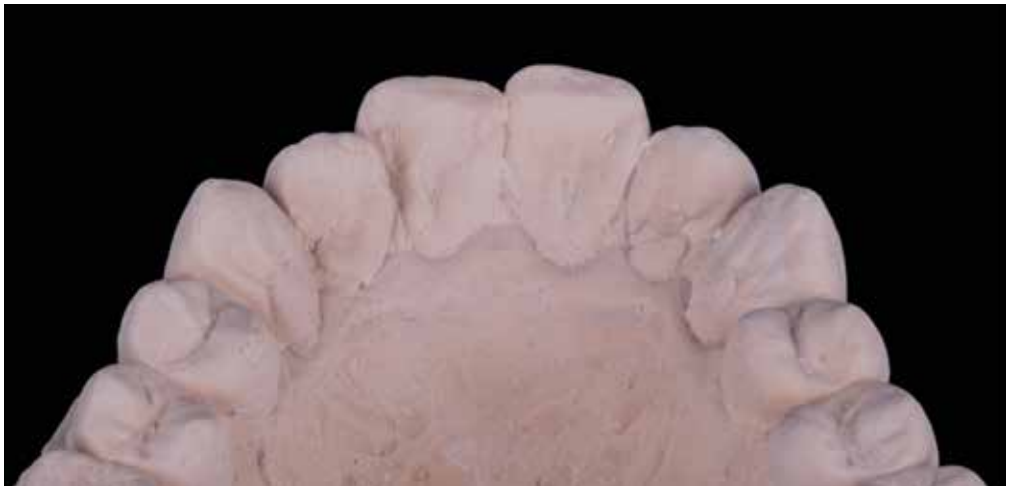


Figure 2: Palatal view of the patient's original pretreatment model.

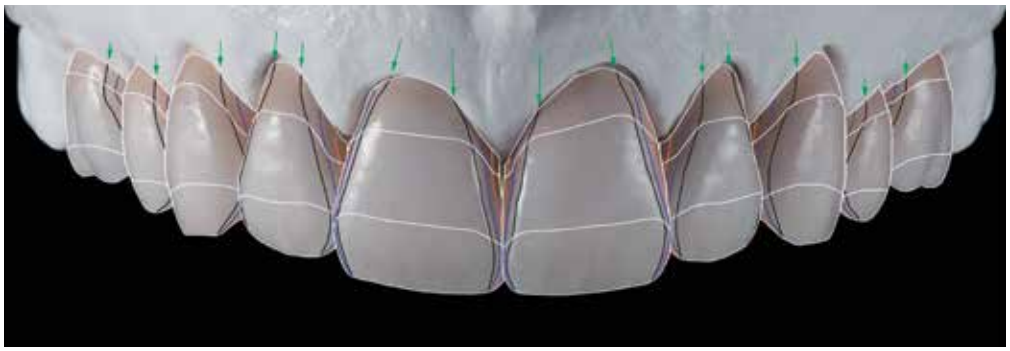


Figure 3: All angles that create harmony and balance were analyzed.

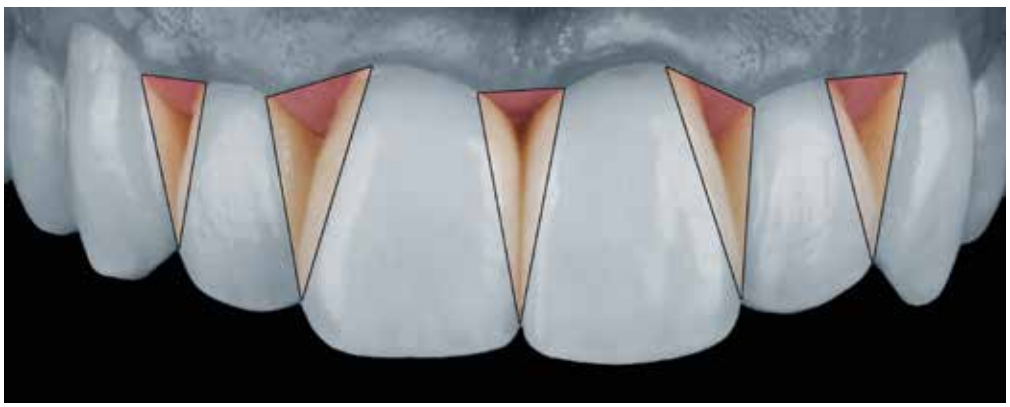


Figure 4: The triangular contact zone comprises proximal transitional surfaces.

Figure 5: Properly conditioned and healthy gingival tissues provide dental technicians with information about where definitive line angles should be placed in final restorations.

Figure 6: The provisional restorations provided information for establishing the height, width, general teeth formation, and definitive shade for the final restorations.

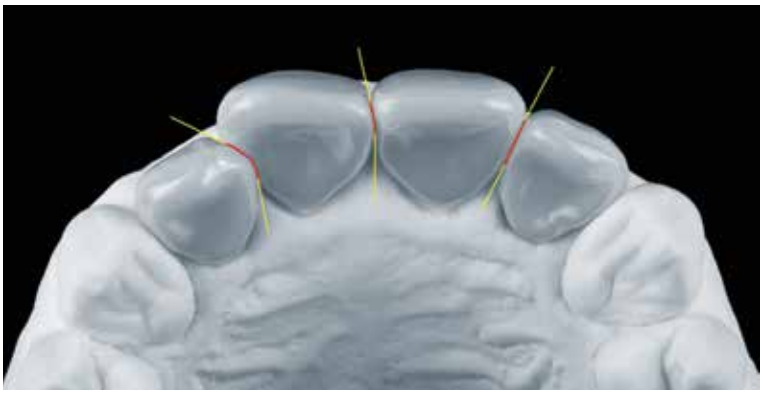


Figure 7: As teeth constantly shift and abrade against each other, contact points that are not always points, but rather patches, and angles that resemble a curvy pathway from one another—as opposed to a straight line—are created.

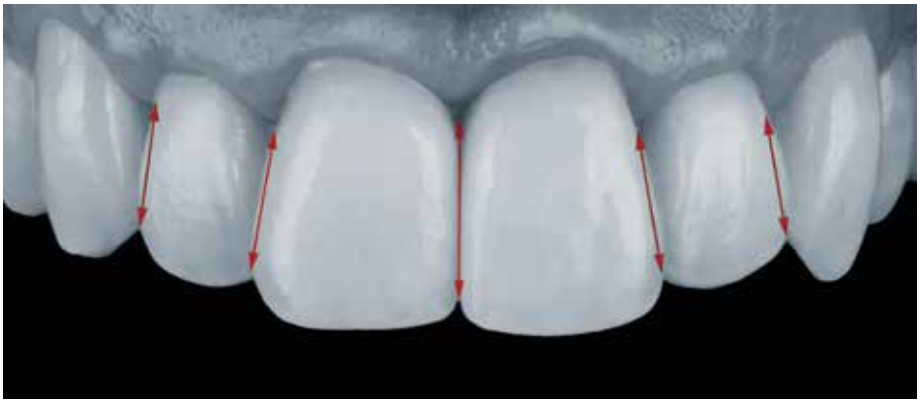


Figure 8: Contact points begin at the height of the interdental papilla and end at the opening point of the incisal embrasure.

Contact points: For all anterior restorations, the contact points of the central incisors are among the main characteristics that dental technicians evaluate and replicate to achieve harmony between the final restorations and adjacent natural teeth or other restorations. Contact points do not have to be in a perfectly straight line; perfectly straight lines do not exist in natural formations, but they can be perceived in nature depending on where and how one observes them. When perfect straightness is observed, the line between the contact points is actually a curvy path to every other point **(Fig 7)**.

Depending on the existing interdental papilla volume, contact points for restorations typically originate near or directly above the height of the interdental papilla and terminate on or near the starting point of the incisal embrasures, as in this case **(Fig 8)**. Originating the contact point at the height of the interdental papilla resolves issues related to interdental black

triangles.[4] Subsequently, the mesial and distal contact points for both lateral incisors in this case were establishing using the same protocol.

The wax-up design now represented the planned definitive restorations. The final texture, form, width, and height of the individual restorations in wax form were evaluated prior to digital scanning for CAD/CAM milling of multi-layer zirconia restorations. The final shade was also approved by the patient.

Line angles: Once the restorations were milled and sintered, they were placed on the model and ready for execution of micro details, beginning with the central incisors and their alpha line angles **(Fig 9)**. Rather than consider the proximal transitional surface and its respective line angle(s) as a singular entity, it is more reflective of nature to subdivide these areas (i.e., two per tooth, one mesial and one distal) into four line angles (i.e., eight total). On both the mesial and distal aspects of a tooth, these line angles move mesial to distal. They can be identified as alpha (most mesial transitional line angle), beta (middle mesial transitional line angle), gamma (middle distal transitional line angle), and delta (most distal transitional line angle).[1]

In cases where the soft tissue architecture is properly contoured, two zenith positions—the highest points in a specific area of a tooth—serve as useful guidelines for creating harmonious alpha line angles: the mesial and distal zeniths **(Fig 10)**. What interconnects the alpha line angles with the contact points are the remaining three line angles (i.e., beta, gamma, delta) **(Fig 11)**. Subdividing mesial and distal areas using these four line angles can benefit every restorative case, particularly in creating the most optimal proximal transitional surfaces.

Once visualized and established, these line angles collectively determine the position and shape of the three planes of the labial restoration surface (e.g., gingival, middle, and incisal thirds) based on the distance of the line angles to the contact points **(Fig 12)**.

> "Although formulating tooth size and ideal gingival architecture is very useful in prosthodontics, there are limitations in achieving optimal results that cannot be justified mathematically."

Figure 9: View of the alpha line angles for the sintered multi-layer zirconia anterior restorations *(Image by Jensen)*.

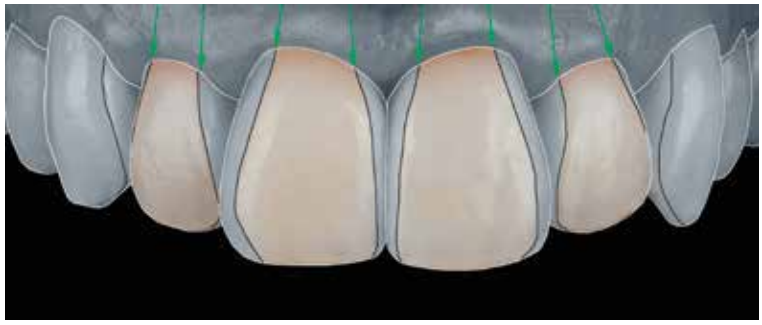


Figure 10: Mesial and distal zeniths (green) provide information for creating alpha line angles.

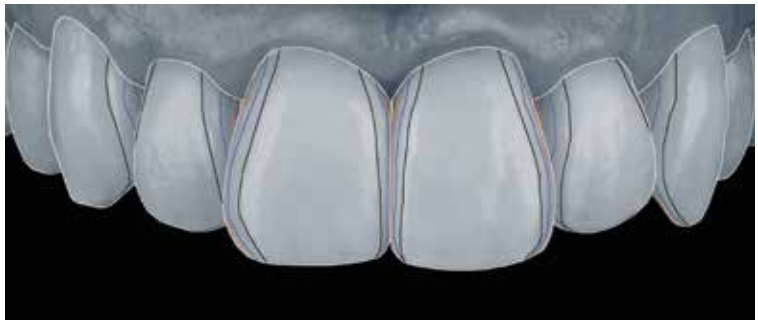


Figure 11: Illustration of the micro details created by the formation of multiple line angles: Alpha (black); Beta (blue); Gamma (orange); Delta (yellow).

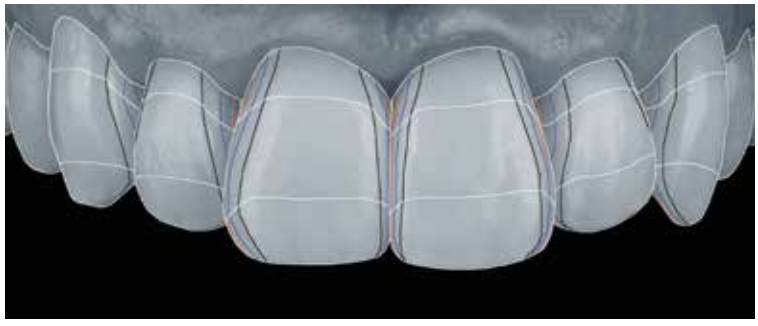


Figure 12: Multiple line angle formations provide guidance for creating three labial tooth plane positions.

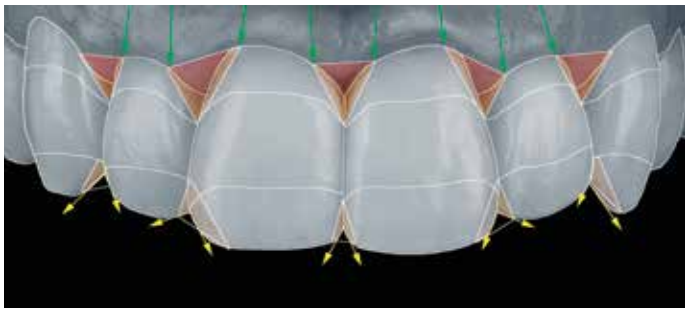


Figure 13: Three labial planes and mesial/distal zenith positions are used as a guide for embrasure space and angles.

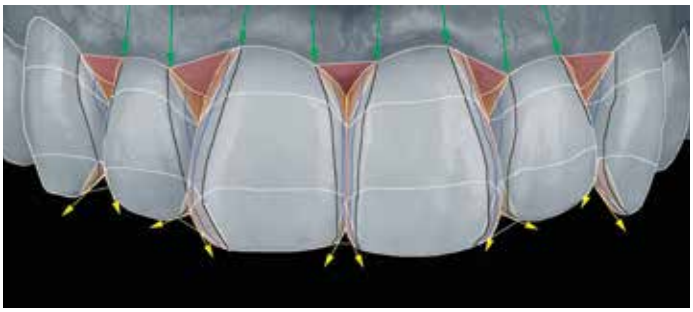


Figure 14: All points and angles are used as guides to finalize restoration shape and form. Note that all points and angles are inter connected to orm a range of one single tooth to multiple tooth restorations.

Figure 15: Labial view of the completed, traditionally layered ceramic restorations.

Figure 16: Palatal view of the completed, traditionally layered ceramic restorations.

Planes: Natural tooth formations inherently exhibit three labial planes that must be evaluated and replicated in restorations to ensure lifelike esthetics. The definitive labial form of restorations is determined by the details and positions of these three planes, the distance and formation of the proximal transitional line angles, and how they connect with the contact points—all of which are interrelated.

Therefore, successfully creating labial planes is predicated on the previous steps. An analogy would be buttoning a shirt: the first button must be in the correct position for the remaining buttons to fall into place.

As in this case, when gingival tissues are in exceptional condition, the soft tissue plane and gingival third of the restoration are usually parallel, creating a smooth emergence profile for the restoration **(Figs 13 & 14)**. Emergence profile is a critical factor requiring astute evaluation and proper execution.

Pursuing Efficient Artistry

Establishing and recreating tooth morphology and micro details in restorations will remain the core components of dental laboratory work, requiring an understanding and mastery of proper techniques. Unfortunately, time constraints, learning curves, and economic pressures can affect a technician's ability to quickly acquire experiential-based knowledge and expertise.

However, today's available technologies, including laboratory CAD/CAM and digital design libraries of natural tooth formations, can facilitate the creation of esthetically precise restorations by enabling technicians to focus more on artistry (e.g., contact spaces, embrasure openings, characterization coloring) and less on routine fabrication tasks (e.g., pouring models; creating traditional wax-ups; waxing, investing, and divesting restorations). Additionally, CAD/CAM technology enables restorations to be completed in less time and with less effort.

For example, the four restorations required for this case were fabricated by three technicians, each of whom used a different fabrication technique. The technicians had the same goal in terms of final form and function, and all used the same color map. The patient's requirements were specific regarding replication of the original palatal formations, enhanced esthetics, and increasing the length and width of the restorations to approximate nature as much as possible. Fabricating three sets of restorations using different techniques enabled evaluation and comparison of the time and resources necessary for the different methods.

Traditional multiple ceramic segmental build-up technique over zirconia copings: This technique, undertaken by Sang Jun, CDT, required a full work day to produce 20-powder ceramic restorations from coping to finished restoration, including firing cycles **(Figs 15 & 16)**.

Figure 17: The 0.5-mm digitally cut back zirconia restorations.

Figure 18: Incisal view of the cut back restorations with putty matrix in place. The position of tooth #10 was shifted in consideration of the value dropping too much compared to tooth #7 due to the difference in position.

Figure 19: Internal characterization was accomplished using an esthetic finishing system prior to micro-ceramic layering.

Figure 20: Labial view of completed micro-ceramic layered restorations.

Figure 21: A full zirconia palatal aspect of the micro-ceramic layered restorations will prevent the restoration from chipping or breaking.

> "Master-level dental technicians must astutely observe the micro details and nuances of natural teeth to replicate them in restorations and achieve a harmonious and balanced outcome."

A combination of the other two techniques using micro-ceramic layering over 0.5-mm digitally cut back zirconia: This method, employed by Don Cornell, CDT, took half a day to layer 0.5 mm and finish the restorations, including firing cycles **(Figs 17-21)**.

CAD/CAM copy/scan technique for milled monolithic zirconia restorations, followed by an esthetic finishing system: After zirconia sintering **(Fig 22)**, this fabrication method, used by the author, required 20 minutes for adding micro details, and 1 to 1.5 hours to color and finalize restoration texture (i.e., structure glaze), including firing cycles **(Figs 23-27)**. Using the Miyo esthetic finishing system (Jensen Dental; North Haven, CT), the author imparted micro details and volume to the full-contour monolithic restorations such that they approximated the appearance of the layered ceramic restorations. This was accomplished while significantly reducing working time and exercising artistic control over restoration fabrication (e.g., multiple color zones, texture, micro details) **(Figs 28-34)**.

Figure 22: Sintered and polished multi-layer zirconia crowns are the starting point for addressing micro details and imparting lifelike characteristics into the restorations.

Figure 23: The full-contour monolithic zirconia restorations prior to color application.

Figure 24: Application of the finishing system. Tooth #8 is fully colored, glazed, and fired. View of tooth #9 with structure paste applied, prior to firing cycle.

Figure 25: The full-contour monolithic zirconia restorations after color and structure application adjacent to the target value shade guide.

Figure 26: The completed full-contour monolithic zirconia restorations.

Figure 27: The polished palatal aspect of the completed full-contour monolithic zirconia restorations.

Figure 28: Finished restoration (photo taken during final try-in).

Figure 29: Intraoral retracted view of the upper and lower arches illustrating balance and harmony of the restorations that closely resemble nature.

Figures 30a & 30b: Images demonstrating how the contact points, angles, and embrasures spaces closely resemble those of natural tooth formations.

Figures 31a & 31b: Lateral view of the restorations during final try-in.

Figure 32: The 20-powder, multi-layer ceramic restorations.

Figure 33: The 0.5-mm micro-layered zirconia cut back restorations.

Figure 34: The full-contour monolithic zirconia restorations after finishing.

Summary

It remains essential for dental technicians to understand how micro details influence the esthetics of natural teeth (i.e., contacts, line angles, planes) and accumulate experiential knowledge and skills in translating those characteristics into restorations. Such expertise is a requirement to ensure lifelike, balanced, and harmonious integration of the restorations within the smile architecture, regardless of how they are fabricated.

Overall, for the restorations in this case, the time difference among the three fabrication methods was dramatic. However, when the esthetics of the restorations were compared directly, the results were extremely close **(Figs 32-34)**. In fact, the patient did not know whether to select the micro-layered restorations or the full-monolithic restorations (the traditionally layered ceramic restorations did not meet his requirements for replicating the exact palatal anatomy of his original pre-restoration model). It is well accepted that it is difficult to duplicate form and position with 100% accuracy using traditional ceramic layering, although technicians do come very close with putty matrices. The author's approach was to utilize today's CAD/CAM technology to simply scan and copy the original palatal design to replicate the desired form.

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> "Whether the restoration is fabricated purely by hand or with the aid of CAD/CAM technology, technicians must determine and carefully execute the creation of micro details to impart lifelike characteristics into anterior restorations."

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Mr. Choi owns a dental laboratory in Wallingford, Connecticut.

Disclosures: Mr. Choi teaches hands-on workshops on the Miyo finishing system for Jensen Dental.