Chairside CAD/CAM aesthetic restorations

By James Klim, DDS, FAGD, AAACD

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Achieving an aesthetic and functional outcome in restorative dentistry depends on numerous factors. One of the most important considerations in an aesthetic treatment plan is the patient's aesthetic expectations and biomechanical factors; having a clear understanding of the steps involved improves the predictability of the proposed restorative treatment. As demonstrated in the following clinical procedure, chairside CAD/CAM technology enable the practitioner to virtually design and then mill high strength restorations to fulfill the objectives set forth preoperatively.

Dentistry is rapidly developing with new products, materials and laboratory applications for the restorative dentist. The advancements in digital optics, virtual design software and precise CAD/CAM machining capability is rapidly advancing fabrication options in restorative dentistry.[1,2] When applying sound periodontal, biomechanical and aesthetic fundamentals to CAD/CAM dentistry, the practitioner can provide a predictable outcome for functional and aesthetic comprehensive restorative treatment.[3]

Aesthetic restorative care starts with understanding the focus of the patient s objectives and expectations. In this particular case, the patient was very specific about closing the spaces between the front teeth and enhancing the size of the front teeth to close the open space between the upper and lower front teeth.

The initial interview process sets the stage for restorative success. This is where treatment and relationship expectations are established between the professional office and patient. From the historical material gathered from clinically focused questions and responses, the clinician can determine the best route to achieve patient and clinical expectations.

Following the interview, records are achieved to gather the necessary information for a restorative oral diagnosis and treatment options. The clinical exam consisted of FMX, periodontal evaluation, digital photographs, study models and oral/nasal airway assessment.

The patient presented a history of airway obstruction via enlarged tonsillar pillars and a deviated nasal condition. The author saw this as a myofunctional contributor to the tongue thrust and future post-treatment retentive factors. A referral was recommended for a sleep study and airway assessment.

Following the records data collection, a wax-up proposal was presented to best determine the aesthetic, soft tissue zenith outline and functional dynamics for the case. Using the metric golden proportion for central tooth length, the upper central incisor edge is determined.[4] The central width/length ratio of 75-85%; in most cases, the centrals are in the 9-10 mm length zone.

The patient accepted an aesthetic treatment proposal of all-ceramic restorations on the upper four incisors to fill space and enhance the aesthetic harmony for tooth size.

Due to the patient s timeline of leaving for college in a few days, we decided to prepare the teeth, place transitional restorations (provisionals) for functional and phonetic assessment and then whiten the remaining teeth in the smile zone. Chairside whitening was undertaken using Zoom! technology (Discus Dental) to achieve an overall lighter tooth colour.

Subtle soft tissue alignment issues were taken care of at the preparation appointment with a diode laser. Care is taken to protect the 2.5mm biological width and adequate attached tissue zone.[5]

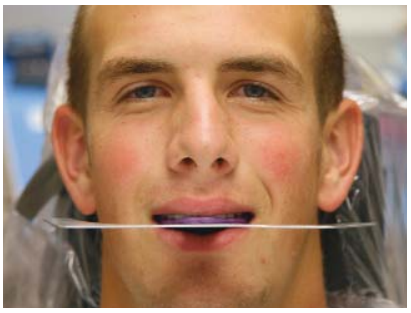
The secret to achieving proper final restorative emergence outline, particularly at the midline, is to control the zenith outline first and then prepare to the zenith outline. In cases where the midline root trunks are not the same size, prepare the tooth with a larger root trunk first for ideal emergence zenith outline and drop the smaller root margin another 0.5 mm from mid tooth to mesial line angle. This will create ceramic clearance for a fuller emergence contour and facilitate flexibility at the design stage to compensate for symmetrical emergence.

The central and lateral incisors are prepared to retrocline final restorations and create ideal interproximal papillae architecture. Interproximal cervical margins were prepared so we could place the interproximal contacts 4.0-4.5 mm from the bone, facilitating a predictable papillae fill of the cervical embrasures.[6] The interproximal margins were feather to the lingual, leaving the lingual unprepared. The lingual full coverage restoration margins are established during the virtual design on enamel near the lingual free gingival margin.

Before the final preparation check, the final pre-planned ceramic and shade needs to be reaffirmed. Preparation design and reduction is primarily controlled by occlusal, functional and pre-colour conditions to achieve final aesthetic objectives.[7]

Though it would have been possible to provide same day restorations using chairside CAD/CAM technology, the author placed transitional restorations to assess tooth size aesthetics, functional envelope and phonetics. The preparations were digitally imaged prior to provisional placement.

Figures 1 and 2. Preoperative view shows aesthetic microdontia, diastemas and anterior open bite due to tongue thrust (orthodontic referral for aesthetic completion).



Figures 3 and 4. Diagnostic wax-up aligned with facial aesthetics, created prototype for smile golden proportions and tooth primary and secondary facial anatomy.

Figures 5 and 6. Central and lateral incisors are prepared to retrocline final restorations and create ideal interproximal papillae architecture.

Figure 7 and 8. Diagnostic provisionals are used to measure for uniform thickness and smile diagnostics prior to the digital impression.

Using the CEREC CAD/CAM technology, multiple optical images of the preparation and adjacent arch teeth were taken to build a virtual die.[8] One advantage of a digital impression is instantaneous preparation and margin assessment. If needed, alterations can be accomplished in the mouth and re-imaged to assure precise margin outline and preparations that will fulfill the engineering requirements for a successful functional and aesthetic outcome.

The CEREC Bluecam camera optics and MCXL milling dimensions are now in the 10-20µm range.[9] Margins, interproximal contacts and occlusion will rival and can now surpass traditional laboratory and impression techniques when applied with detailed precision by the operator.

The CEREC software allows the operator to overlay the virtual wax-up model over the

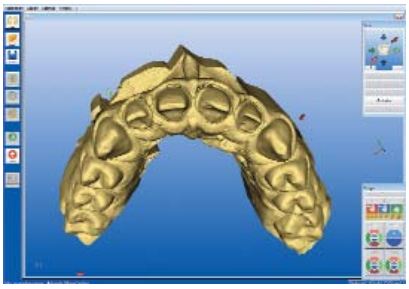


Figure 9. Virtual cast captured via four stitched optical impressions, facilitates operator to assess preparation design and margins before the design process.

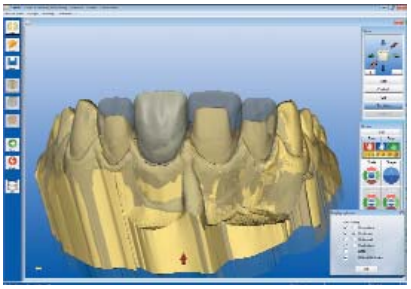


Figure 10. Design software allows operator to overlay virtual wax-up model over the virtual preparation model to precisely propose and design restorations dimensionally identical to wax-up.

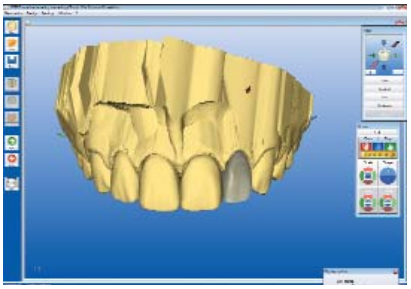


Figure 11. While the centrals are milling, the remaining incisors are designed in tandem sequence for proficient design and milling time (approximately 7-8 minutes milling time per tooth).

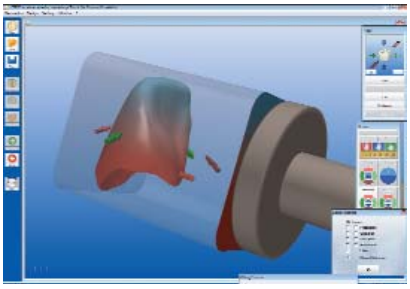


Figure 12. The digitally designed central is positioned in an Empress CAD layered block to "reproduce" the desired shade, chroma and transparent gradation as found in a natural tooth.

Figure 13. Machined central still attached to the milled block. This view shows the precise smooth margin outline. This is the physical reflection of well-defined preparation margins.

Figure 14. Final contours shaped and defined on stone model.

Figure 15. Subtle blue and white stains are used to highlight incisal stump mamelon effects and then oven fired.

Figure 16. Layer of glaze will seal in the stain highlights and achieve tooth-like lustre once fired.

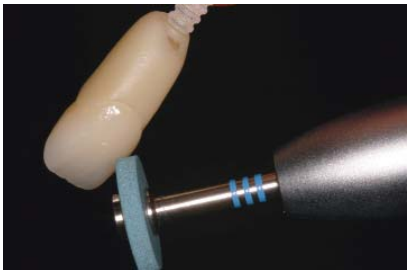


Figure 17. The labial convex surfaces are smoothed and polished to a higher lustre.

virtual preparation model to precisely propose and design restorations dimensionally identical to wax-up. When crossing the midline, the author designs the centrals first. The mesial cervical embrasure is determined by mesial margin outline and to some extent can be compensated for during the virtual design process when dealing with asymmetrical root trunks. The larger root trunk trumps the emergence profile, so virtual design and shape first.

Once the centrals are designed and are in the process of milling, the remaining lateral incisors are designed in tandem

Figure 18. Internal of restorations are steam cleaned before hydrofluoric acid application for 30 seconds and then rinsed and dried, followed with Monobond Silane application.

Figure 19. Final restorations illustrate the possibilities with the current CEREC software and Empress CAD Multi ceramics.


Figures 20 and 21. Customizing texture and superficial gloss creates vital light transmission and reflection features required to avoid the artificial look.

Figure 22. Current CAD/CAM ceramics facilitate mamelon effects accomplished with preparation "shine-through optics" as positioned in the transparent zone of the gradated ceramic block.


Figures 23 and 24. Life changing smile transformation accomplished by treating the maxillary four incisors with chairside CAD/CAM CEREC technology.

sequence for proficient design and milling time from the same virtual die (approximately 7-9 minute milling time per tooth).

One of the aesthetic advantages of CAD/CAM ceramics is the inherent cervical-incisal gradient zones (IPS Empress CAD Multi). The virtual restoration, prior to milling, can be positioned in the virtual block to reproduce the desired gradient zones to best aesthetically blend the restoration. In many ways, we are recreating similar colour/transparency transition and optic influences as seen in a natural tooth.

The preparation stump shade and margin design plays an intricate part to the final cervical chroma outcome. When applicable to the case, using the dentin optical colour shine-through will give vitality and depth to the final restoration.

Pre-mill block selection is primarily determined by desired brilliance for the incisal half of the restoration. The cervical half can then be controlled by depth of preparation (thickness of ceramic), margin design (chamfer, shoulder, or feather), virtual block opacity, placement of virtual restoration positioning in the IPS Empress CAD Multi block relative to block size (12, 14, 14L) and stain characterizing.

During the adhesive period, the bonding resin can be used in the body and cervical zones to increase brilliance or gain warmth to the final desired outcome.

Studies affirm that the machined ceramics have inherently better functional properties (less likely to fracture) than traditional laboratory stacked or pressed ceramics because of the industrial manufacturing process.[10,11,12]

The primary contours and cervical emergence profiles are established in the virtual design process. The surface textural features are defined following the mill but prior to stain application. Incisal highlights and cervical/interproximal stain characteristics are applied and fired prior to glazing. In the more visually critical anterior zone, stain firing prior to glaze will give more optical depth to the applied colours when an independent stain firing is used.

The author prefers a cast model for final shaping and finishing procedures once the machining process is accomplished. Finishing techniques are applied to "fingerprint" the desired aesthetic presentation.

For more incisal depth look with the IPS Empress CAD Multi blocks, it is possible to achieve excellent incisal effects without a full cutback. Apply subtle mamelon reduction to only the labial surface staying 0.5 mm from the incisal or mesial distal edge. Apply IPS Wash Paste Modifiers, preferably blue and white combination, fire and then add back a thin layer of medium Incisal Opalescent ceramic. Leaving the incisal edge intact maintains the pure functional strength ceramic quality.

The ceramic finishing artistic caveat to fooling the eye starts with tooth profile, which we can call the tooth figure. In addition, customizing the reflective and deflective surfaces and texturing creates an individuality and uniqueness for each case. But even considering these important artistic tooth principles, the superficial gloss finish is what completes the "fingerprint" act. This is created with glaze style application and postglaze polishing.

The superficial gloss finish is applied after the glazing process. The labial convex surfaces are smoothed and polished to a higher lustre. Medium and high gloss polishing wheels are used primarily on the mesial and distal line angles. Be careful to avoid polishing away wanted surface texture.

Final surface lustre can also be controlled with a Robinson wheel and diamond pastes (Diashine).

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temporary resin cement that contained fluoride, potassium nitrate for desensitizing and antimicrobial chlorhexidine (NexTemp™, Premier Dental Products).

The impression was sent to the dental laboratory for fabrication of the all-ceramic crown with a zirconia coping (Procera®, Nobel Biocare). The crown was returned by the laboratory and was tried in and adjusted for proximal contact and occlusion. The margins were evaluated and determined to be very well-fitting. The Procera crown was cemented using the same adhesive technique as was described for the post system - self-etching bond enhancer (Bond Boost SE) applied for 20 seconds and dried, dual-cure fifth-generation adhesive (IntegraBond) and a dual-cure composite resin cement (IntegraCem). The cement was applied in a thin layer into the cavity of the crown and the crown was cemented, having the patient gently bite down on a saliva ejector to provide mechanical force to fully seat the restoration. The cement was cleaned away and the occlusion was checked again. The final restoration was highly aesthetic (Figures 13a-b).

Conclusion

With the latest generation of composite core materials, restoring structurally deficient teeth with an adhesive composite resin is an acceptable alternative to traditional amalgam cores. Major benefits of using a composite core material are rapid set for immediate preparation for a crown, no need for additional retention because of adhesive technique and acceptable physical properties to support a crown.

About the authors

Dr Howard E. Strassler is Professor and Director of Operative Dentistry, Department of Endodontics, Prosthodontics and Operative Dentistry, University of Maryland Dental School Baltimore, Maryland.

Dr Lyndsay C. Bare, is a Resident of the AEGD Program at the University of Maryland Dental.

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With so many cement adhesive systems on the market, pay particular attention to the system being used. Apply adhesive steps with a microscopic mindset. Schedule adequate time for this appointment so the clinician can take the necessary time and pace for predictable adhesive results. The secret to adhesive management is to systematize each step for predictability and efficiency.

Conclusion

Aesthetic chairside CAD/CAM will take restorative dentistry to new creative heights as the technology continues to evolve. As it is already happening, it will be the laboratory standard soon. However, the basis of success still relies on the critical elements demanded for sound restorative care: diagnosis, periodontal support, biomechanical application, preparation design, sound optical impressions and bite records, placement protocols and finishing.

Virtual design and ceramic machining is creating an attractive alternative to investing and pressing or stacking ceramics. The CAD/CAM ceramics have natural tooth gradation/colour transitions already designed in the ceramic, so the aesthetic result can be very natural without layering and firing ceramic applications.

When the CAD/CAM ceramics are bonded with precise clinical technique, they will surpass tooth strength and yet have wear properties that are as biologically compatible as enamel. Welcome to the new area of restorative aesthetic dentistry.

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About the author

Dr James Klim is an international speaker, author and instructor on dental technology, practice development and aesthetic dentistry and has taught at several advanced post graduate institutes around the US. He has been awarded fellowships from the Academy of General Dentistry and Academy of Dental-Facial Esthetics and currently has a full time restorative practice in Santa Rosa, California. He is the founder and director of CADStar™, a learning centre for advanced CEREC education.