Maxillary rehabilitation with a CAD/CAM-fabricated, long-term interim and anatomic contour definitive prosthesis with a digital workflow: A clinical report

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The digital workflow in this clinical report describes a maxillary rehabilitation with an articulator-free and definitive cast-free treatment protocol for computer-aided design and computer-aided manufacturing (CAD/CAM) fabricated long-term interim and anatomic contour monolithic lithium disilicate definitive restorations. (J Prosthet Dent 2013;110:1-7)

Single visit anatomic contour restorations became available with the introduction of chairside computer-aided design and computer-aided manufacturing (CAD/CAM) systems[1-4] (CEREC Acquisition Center; Sirona Dental Systems, Charlotte, NC; E4D Dentist; D4D Technologies, Richardson, Texas) and improvement in available restorative materials.[5-8] With more contemporary options for digital data acquisition (Cadent iTero, Cadent Ltd, San Jose, Calif; Lava Chairside Oral Scanner COS, 3M ESPE, St Paul, Minn), the scan data can be electronically transmitted to a corresponding production center,[9] and the optional physical definitive cast can be fabricated with a subtractive milling process or an additive printing process known as stereolithography.[1,9,10-14] The dental laboratory also has the opportunity to obtain the digitally articulated virtual definitive casts to complete the CAD of the interim or definitive restoration without the fabrication of physical casts.[11-14] Various restorative materials, including metal alloys, ceramics,[15-21] and composite resins,[22-30] have been proposed for the subsequent CAM production of interim and definitive restorations. This clinical report describes a complete maxillary rehabilitation with CAD/CAM-fabricated long-term interim and definitive lithium disilicate restorations with a digital workflow that does not require an articulator or a definitive cast.

CLINICAL REPORT

A healthy 80-year-old woman presented with 6 maxillary anterior fractured porcelain laminate veneers. The veneers had been provided 10 years previously in a private practice to correct esthetic problems, and failure was attributed to compromised bonding and exposed dentin. Oral and radiographic examination revealed the presence of extensive direct posterior restorations on the remaining maxillary dentition from the right second premolar to the left second molar (Fig. 1). The mandibular dentition demonstrated an uneven plane of occlusion with extruded anterior teeth. The patient had rejected the option of correcting the mandibular plane of occlusion because of financial restrictions and indicated a wish to proceed with the dental treatment of the mandibular dentition when financially possible. She accepted a treatment plan to restore the remaining maxillary dentition with single unit ceramic complete coverage restorations. She understood the benefits and risks of all proposed treatment options, and the treatment consent was obtained.

A maxillary diagnostic waxing was completed with tooth colored wax (Diagnostic wax; Blue Dolphin, Morgan Hill, Ga) (Fig. 2A) on articulated diagnostic casts. Abutment teeth preparations were completed, and the chairside interim restorations were fabricated from a vacuum formed matrix (.020" Clear Temporary Splint Material; Buffalo Dental Mfg, Syosset, NY) (Fig. 2B) and autopolymerizing acrylic resin (Jet Tooth Shade Acrylic; Lang Dental Mfg Co, Wheeling, Ill). The 1-piece interim restoration was inserted with interim cement (TempBond Clear; Kerr Corp, Orange, Calif), and the patient was asked to return in 1 month to allow time to evaluate both esthetics and function before the definitive impression appointment (Fig. 2C).

The double-cord technique was used for soft tissue management during definitive impression making (Fig. 3). The interim restoration was then

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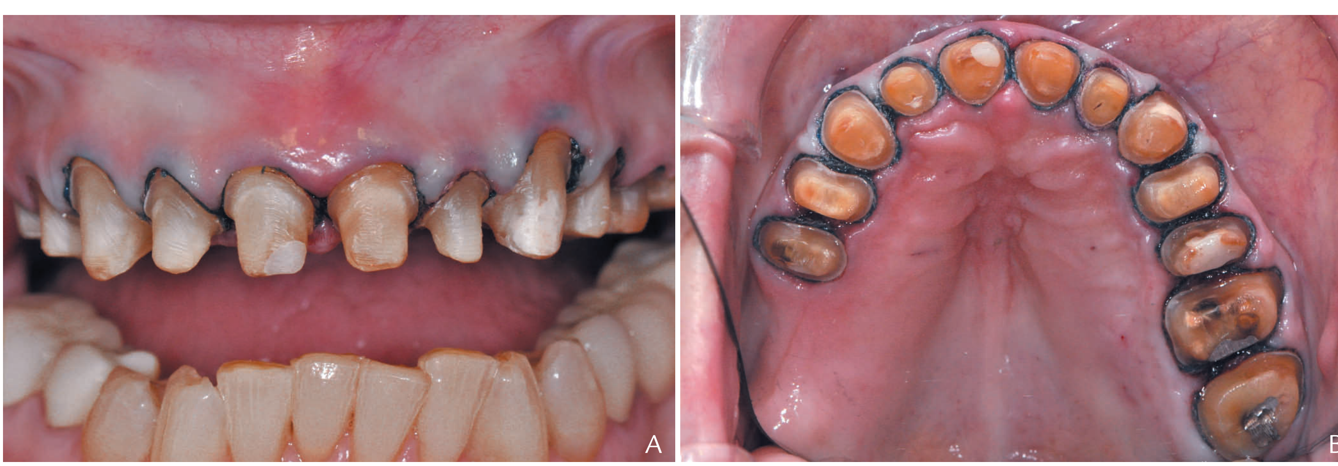
1 Pretreatment condition. A, Frontal view. B, Occlusal view. C, Smile. D, Pretreatment periapical radiographs.

sectioned interproximally between the canines and lateral incisors to provide 3 segments (right, front, and left). The definitive impression was captured with an intraoral digital scanner (Cadent iTero; Cadent Ltd), and the sectional interim restorations were used to maintain the established maxillomandibular relationship during interocclusal record registration. The completed scan data were transmitted to a manufacturing facility and a dental laboratory (Roy Dental Laboratory, New Albany, Ind) to identify and mark crown margins and perform virtual ditching and articulation (Fig. 4). The new interim crowns were designed from the digital library in the CAD/CAM system (Straumann CARES; Straumann USA, Andover, Mass) with minor modification by the dental technician (Fig. 5A). The new individually milled CAD/CAM interim crowns were fabricated from polymethyl methacrylate (PMMA) resin (Polycon AE; Straumann USA) and were evaluated intraorally (Fig. 5B, C) to confirm occlusal function and the esthetic results. At the 1-month postinsertion appointment, the patient expressed the desire to increase the mesial-distal width of all 4 maxillary incisors.

The designs for definitive restorations were modified from the CAD file of interim restorations according to the patient's feedback (Fig. 6A). Anatomic contour monolithic lithium disilicate restorations (IPS e.max CAD, HT, A3; Ivoclar Vivadent, Amherst, NY) were milled at a milling facility (Straumann USA). The trial insertion of the milled restorations was completed in the precrystallized state to allow verification of the marginal fit, internal adaptation, esthetics, and occlusal function (Fig. 6B, C).[31-34] The modified precrystallized definitive restorations were returned to the dental laboratory for completion.

At the insertion appointment, the marginal adaptation and restoration fit were verified with a polyvinyl siloxane material (Fit Checker Black; GC America, Alsip, Ill),[32] and all proximal and occlusal surfaces were verified with articulation film (AccuFilm; Parkell Inc, Edgewood, NY); minor adjustments were made as indicated with rotary instruments (LD13M LD grinder pink medium; Brasseler USA, Savannah, Ga). The restorations were then luted with a self-adhesive, autopolymerizing resin cement (SpeedCEM; Ivoclar Vivadent). The residual cement was removed and postinsertion home care instructions were provided to the patient (Fig. 7A-C). Periapical radiographs were used to confirm the complete seating of definitive restorations and the removal of residual luting agent (Fig. 7D). The patient was also enrolled in a hygiene program with 6-month intervals and demonstrated no complications during the 12-month follow-up period.

2 Completed maxillary diagnostic waxing with tooth-colored wax and preparation guide for initial chairside interim restorations. A, Diagnostic waxing. B, Preparation guide from diagnostic waxing. C, Completed 1-piece chairside interim restoration.

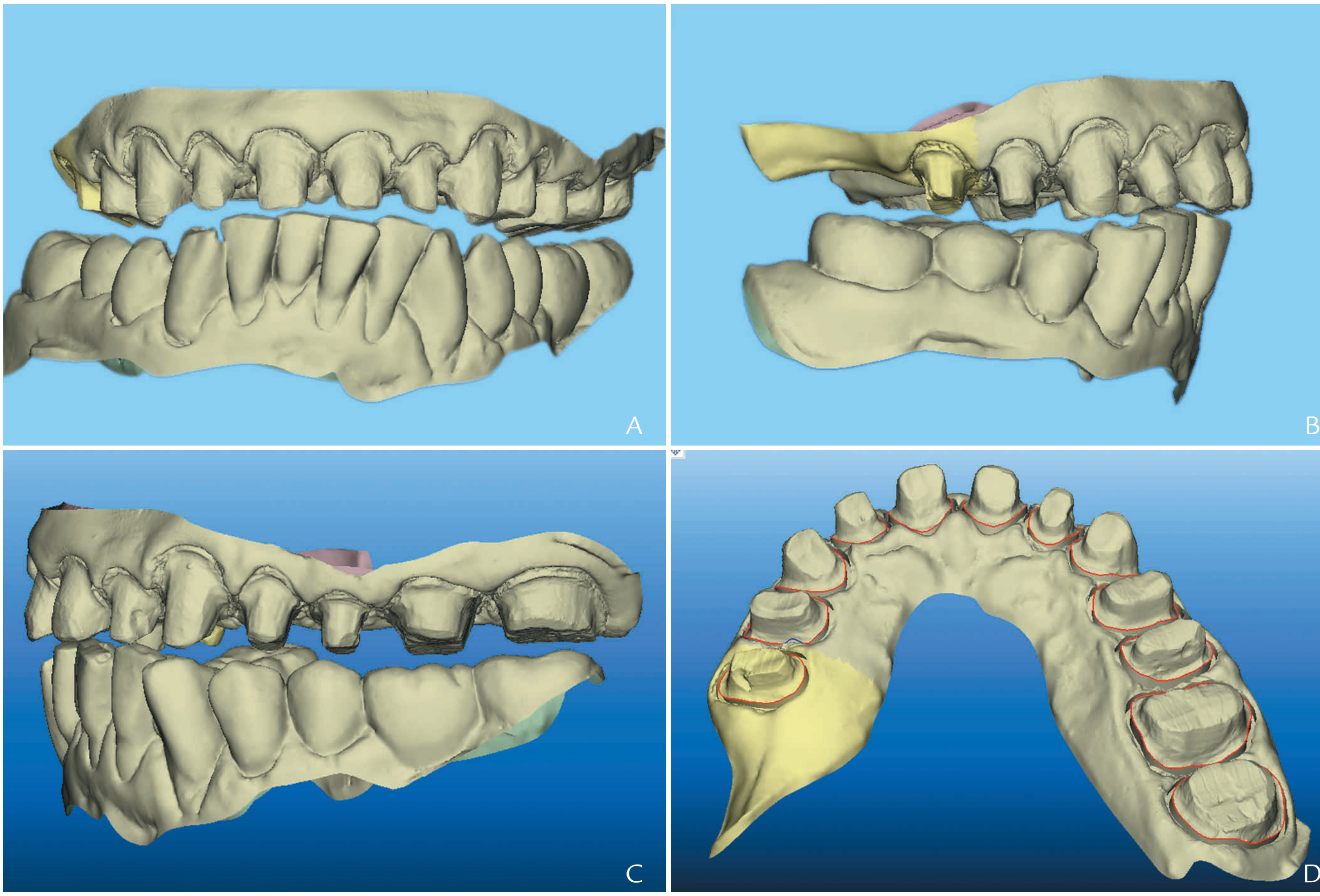


3 Soft tissue management and prepared abutments during definitive impression. A, Frontal view. B, Occlusal view.

DISCUSSION

The proposed workflow has the benefit of managing the investment required into digital dentistry by both the clinician and the dental laboratory (intraoral digital scanner for clinician, and the CAD software for dental laboratory),[3] and centralized production can then provide the highest quality CAM option. The CAD software has limitations and does not permit a highly customized digital restoration design. This limitation may restrict the esthetic potential of restorations if the software is not operated properly.[23,24] Dental laboratory technicians requires additional training and experience to become proficient and effective in the field of digital dentistry.

The long-term CAD/CAM fabricated interim restorations used in this report provided an improved standard of fit, an enhanced esthetic outcome, and improved biocompatibility, although they were associated with an additional laboratory cost.



4 Digitally articulated maxillary definitive cast and mandibular opposing cast. A, Frontal view. B, Right buccal view. C, Left buccal view. D. Digital maxillary definitive cast with identified finish lines and virtual ditching.

[23,24,28-30] When the definitive prosthesis is produced with CAD/CAM technology, the CAD design of interim restorations can be used in conjunction with the desired restorative material to replicate a tested and accepted functional and esthetic result. Although trial insertion of anatomic contour definitive restorations at the precrystallized state limits the patient's ability to examine the final shades, the possibilities for ceramic failure as a result of surface modifications are reduced.[33] The clinicians determined that the anatomic contour monolithic crowns were sufficient to fulfill the patient's esthetic need while maintaining maximum strength of the restorations, simplifying the dental laboratory process, and lowering the final costs for both patient and clinician.

This report also proposed an articulator-free and definitive-cast-free digital workflow for milled long-term interim and definitive restorations. The occlusal vertical dimension in this clinical report was supported by the initial chairside interim restorations to capture the proper maxillomandibular relationship when each occlusal record registration scan was prompted during the digital impression process. To improve the treatment outcomes of complete digital workflow, the incorporation of a digital facebow transfer record into the virtual articulator and CAD software is needed.[23]

SUMMARY

This clinical report presented an digital workflow for maxillary rehabilitation that does not require an articulator or a definitive cast. To obtain a predictable clinical outcome, long-term milled interim restorations were used to support healing soft tissue and confirm the articulation of digital definitive casts. Trial insertion of milled lithium disilicate restorations in the precrystallized state was carried out to maximize the clinical result with the patient's direct feedback and minimize surface and subsurface damage during the clinical adjustment procedures.

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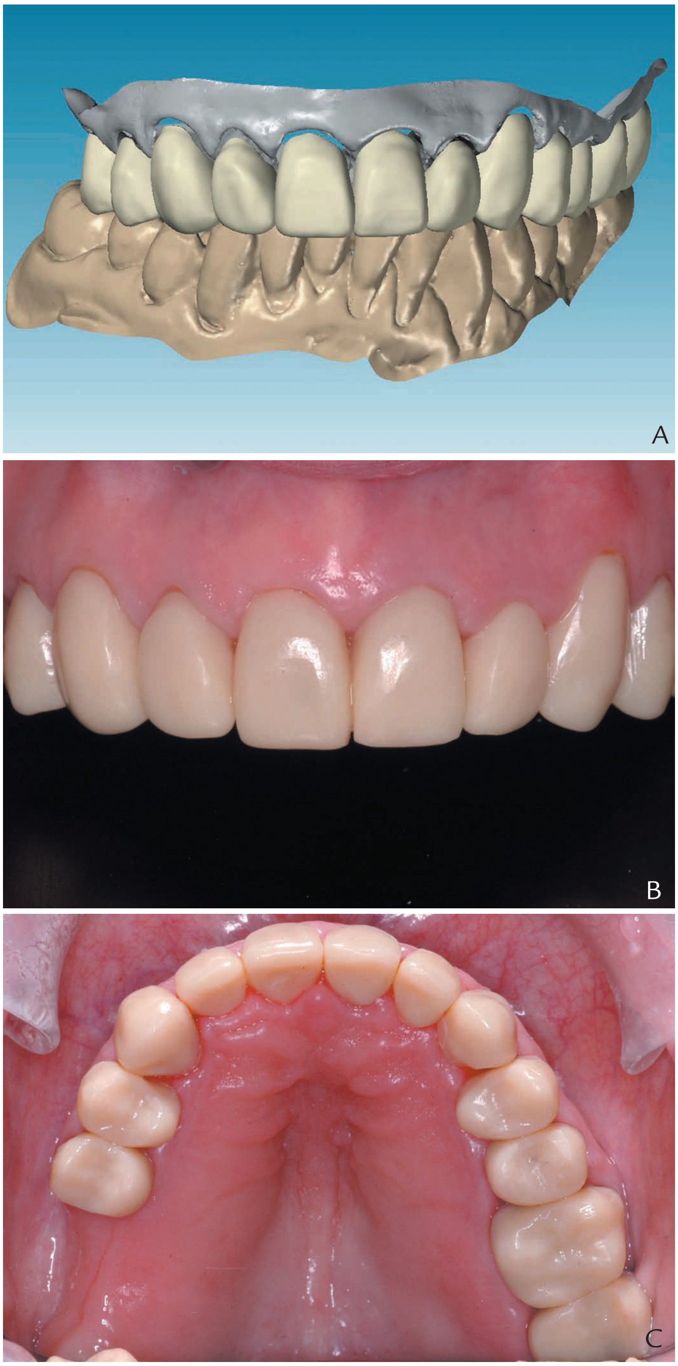
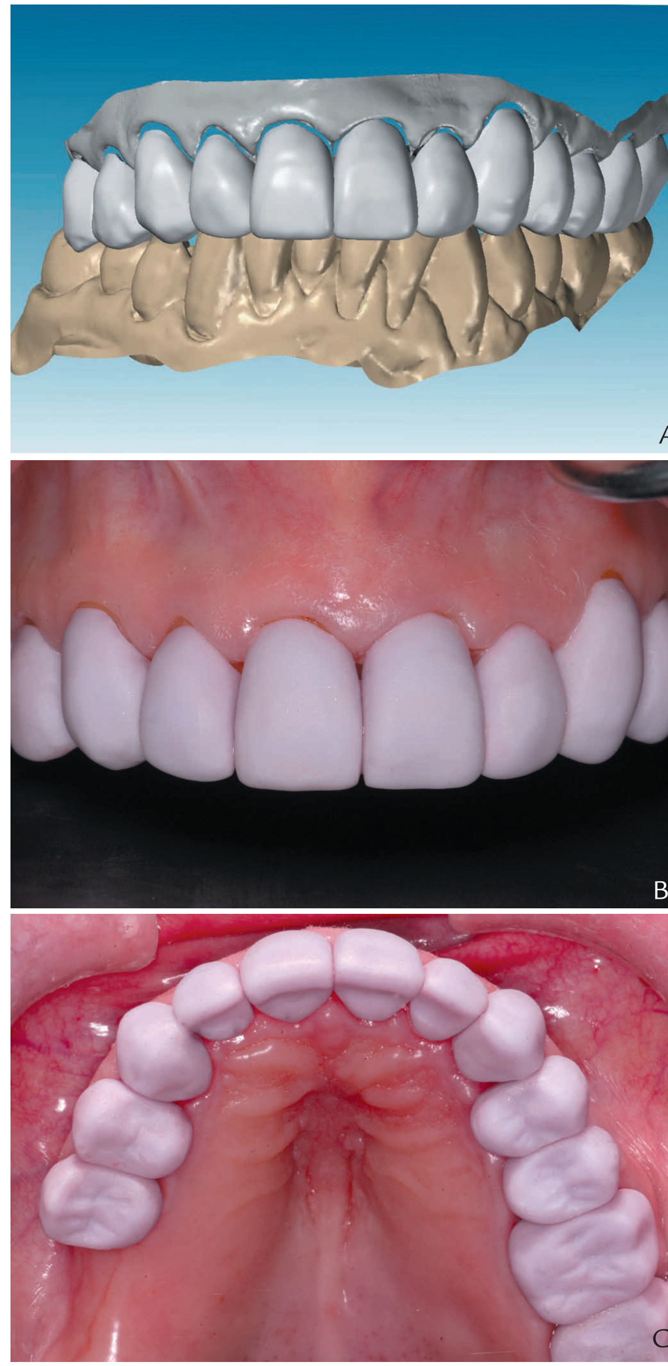


5 CAD/CAM-fabricated PMMA interim restorations. A, Approved design. B, Frontal view of milled interim restorations. C, Occlusal view of milled interim restorations.



6 CAD/CAM-fabricated definitive lithium disilicate ceramic restorations. A, New design approved by patient with increased mesial-distal width at maxillary lateral and central incisors. B, Trial insertion of milled definitive lithium disilicate restorations in precrystallized state. Frontal view. C, Occlusal view of trial insertion.

7 Definitive monolithic lithium disilicate ceramic restoration with extrinsic characterization. A, B, Frontal view. C, Occlusal view. D, Postoperative periapical radiographs.

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Noteworthy Abstracts of the Current Literature

Evaluation of marginal and internal fit of ceramic crown copings

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Dent Mater 2013;29:174-80

Objectives: To measure the marginal and internal adaptation of different prosthetic crowns infrastructures (IS); (2) to analyze two types of methodologies (replica and weight technique) used to evaluate the adaptation of indirect restorations.

Methods: Ceramic IS were fabricated using CAD/CAM technology and slip-casting technique, and metal IS were produced by casting (n=10). For each experimental group, the adaptation was evaluated with the replica (RT) and the weight technique (WT), using an impression material (low viscosity silicon) to simulate the luting agent. Cross-sectional images of the silicon replica were obtained and analyzed with Image J software to measure the low viscosity silicon layer thickness at pre-determined points. The silicon layer was also weighted. Results were statistically analyzed with ANOVA and Tukey's test (α=0.05). Pearson correlation was used to analyze the relation between the two types of evaluation methods.

Results: All IS evaluated showed clinically acceptable internal and marginal adaptation. Metal IS showed the best adaptation, irrespective of the measuring technique (RT and WT). The IS produced by CAD-CAM showed greater gap values at the occlusal area than at other evaluated regions. The IS produced by the dental laboratory technician showed similar gap values at all evaluated regions. There is no correlation between RT and WT ($p>0.05$).

Significance: Different levels of adaptation were found for the different experimental groups and for the different evaluation methods. However, all IS evaluated showed clinically acceptable values of marginal and internal adaptation.