THE JOURNAL OF PROSTHETIC DENTISTRY

CLINICAL REPORT

Comprehensive digital approach with the Digital Smile System: A clinical report

Alejandro Sanchez-Lara, DDS,[a] Konstantinos M. Chochlidakis, DDS,[b] Evangelia Lampraki, DDS,[c] Riccardo Molinelli,[d] Fabrizio Molinelli, DDS,[e] and Carlo Ercoli, DDS[f]

ABSTRACT

This clinical report describes a comprehensive digital approach with the Digital Smile System (DSS) and its clinical use in the prosthetic treatment of a patient for whom 6 anterior maxillary porcelain veneers were fabricated. Following this digital protocol, extraoral facial images and a diagnostic intraoral digital scan were obtained. Digital smile analysis, virtual diagnostic waxing, and milled trial restorations were made in the diagnostic phase. After tooth preparation, data from digital scans were used in the computer-aided design and computer-aided manufacturing (CAD-CAM) of the definitive restorations. (J Prosthet Dent 2019;121:871-5)

Smile analysis is an essential step in the diagnosis and treatment planning of prostheses in the esthetic zone.[1,2] Conventional prosthetic workflows for these restorations attempt to achieve patient approval and adequate communication with the dental laboratory technician with the use of conventional diagnostic waxing, clinical trial restorations, and interim restorations.[3-5] Unfortunately, errors can occur during such procedures, resulting in discrepancies in the planned restorations, increased treatment time, additional costs, and patient dissatisfaction.[6]

Digital smile analysis, general photo-editing, or presentation software programs are practical tools with variable potential to enhance esthetic diagnosis, simplify communication and interaction with the patient, dental laboratory technician, and other clinicians, and, consequently, improve the predictability of treatment.[7] Other potential advantages are decreased treatment time, increased clinical efficiency, and increased patient acceptance and satisfaction.[8,9] Two- and 3-dimensional digital workflows also present a predictable alternative to ensure esthetic information gathered during diagnosis and treatment adequately flows in the design, fabrication, and delivery of the definitive restorations.[10]

Porcelain laminate veneers (PLVs) have been demonstrated to provide clinically acceptable, minimally invasive, esthetic treatment options.[10-14] PLVs can be fabricated with computer-aided design and computer-aided manufacturing (CAD-CAM) systems that enable accurate design while maintaining similar success rates when compared with PLVs produced by conventional techniques.[10-16] Fixed dental restorations fabricated from digital scans can have better marginal and internal fit than the ones fabricated from conventional impression techniques.[17]

This clinical report describes a comprehensive digital workflow used in the diagnosis, planning, and fabrication of lithium disilicate PLVs using the Digital Smile System (DSS) and CAD-CAM technology.

CLINICAL REPORT

A 25-year-old man with a noncontributory medical history presented to the Department of Prosthodontics at

[a]Assistant Professor, Department of Prosthodontics, Eastman Institute for Oral Health, University of Rochester, Rochester, NY.
[b]Assistant Professor, Assistant Program Director, Department of Prosthodontics, Eastman Institute for Oral Health, University of Rochester, Rochester, NY.
[c]Private practice, Dubai, United Arab Emirates.
[d]Product specialist, Ispra, Italy.
[e]Dental Technologist, Ispra, Italy.
[f]Professor, Chair and Program Director, Department of Prosthodontics, Eastman Institute for Oral Health, University of Rochester, Rochester, NY.

Figure 1. Preoperative intraoral view of maxillary teeth.

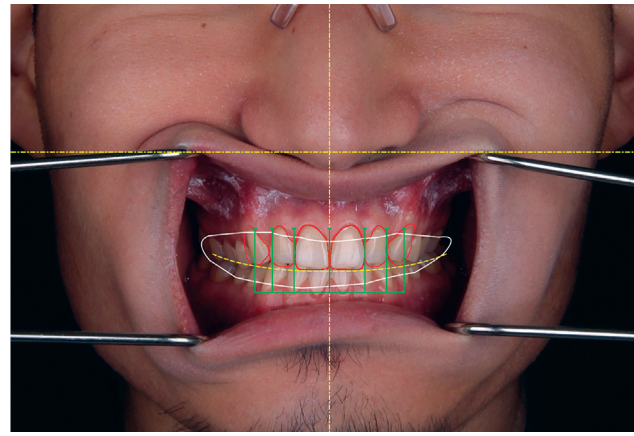

Figure 2. Digital Smile System protocol; positioning and customizing selected teeth after superimposition of smile display image.

the Eastman Institute for Oral Health, University of Rochester, with the chief complaint of unsatisfactory esthetics of his maxillary anterior teeth. The clinical and radiographic examination revealed healthy periodontal conditions and minor attrition of the anterior maxillary teeth from the patient's parafunctional habits, causing a reverse smile appearance (Fig. 1). The patient did not report any parafunctional habits during the diagnostic phase. There was no evidence of occlusal/incisal wear in the opposing arch. Occlusal analysis revealed Angle Class I, horizontal and vertical overlaps of 1 mm, and mutually protected occlusion during mandibular movements. Different treatment options with their associated risks, benefits, and costs were presented and discussed with the patient, including no treatment. The patient elected to proceed with the fabrication of porcelain veneers on the 6 maxillary anterior teeth.

According to the DSS workflow, 2 extraoral digital photographs were made while wearing special eyewear that allowed the software to automatically superimpose the 2 images. Both photographs were captured using a tripod, with the patient's head held stable to achieve a consistent head position in both images. The acquired images included a frontal facial view in exaggerated smile and a frontal facial view with full lip retraction and teeth in maximum intercuspal position. The images were uploaded in a 2D digital smile analysis software (DSS) to perform the smile analysis and digital design of the proposed restorations (Figs. 1, 2).

An intraoral scanner (True Definition Scanner; 3M ESPE) was used to obtain an intraoral digital scan of both arches. On the patient's acceptance of the proposed 2D design, the files from the 2D system and the intraoral scanner were uploaded and combined on the 3D-DSS software (Fig. 3) to allow for the 3D design and fabrication of the veneers (Fig. 4). At that point, a mesh of the virtual diagnostic waxing was milled from a polymethyl methacrylate block using a CAM system (Ceramill; Amann Girrbach AG). The trial restorations were then

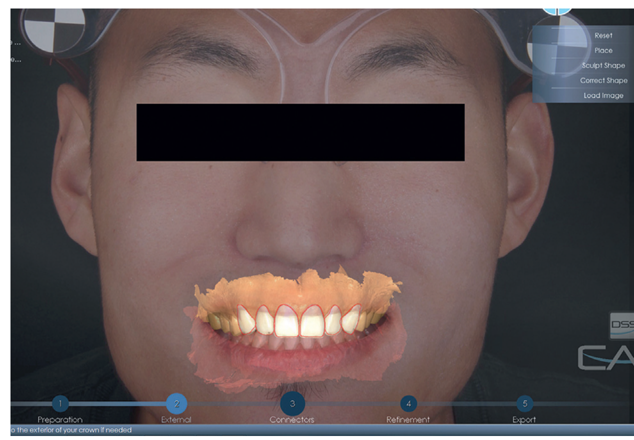

Figure 3. Superimposition of pretreatment scan and facial picture. Proposed digital waxing designed on scan and correlated with smile photograph.

evaluated intraorally to obtain the patient's final consent for the proposed dental treatment to assess the esthetics, phonetics, and occlusion of the treatment (Fig. 5) and to guide tooth preparation.

The standard tessellation language (STL) file of the cast and proposed porcelain veneers was then used to 3D print (Form 2; Formlabs) a cast using light-polymerizing resin material (Dental Model Resin; Formlabs). A silicone matrix (Virtual Putty Regular; Ivoclar Vivadent AG) was then fabricated on this cast and used to aid in the fabrication of the interim veneers (Fig. 5).

During tooth preparation, the trial restorations were temporarily cemented using a spot-etch technique and were used to guide a minimally invasive tooth preparation design, thereby preserving maximum enamel structure. Following tooth preparation, a single gingival displacement cord (size "0", Ultrapak; Ultradent Products, Inc) was placed in the

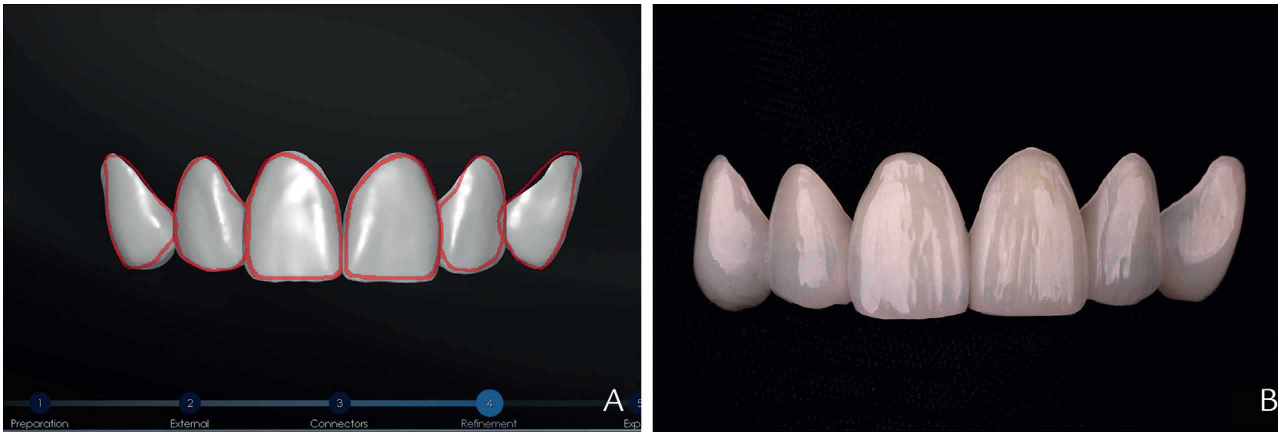

Figure 4. Digital diagnostic waxing. A, Mesh of digital diagnostic waxing without teeth. B, Milled trial restorations from polymethyl methacrylate block.

Figure 5. Intraoral view of milled trial restorations in maximal intercuspal position.

gingival sulcus, and a definitive digital scan was made using an intraoral scanner (True Definition Scanner; 3M ESPE) (Fig. 6).

The porcelain veneers were then designed using CAD technology (Ceramill; Amann Girrbach AG) and the 3D design previously accepted by the patient and incorporating a slight incisal cutback to allow for feldspathic porcelain veneering. The veneers were individually milled from lithium disilicate blocks (A1 Shade, IPS e.max CAD; Ivoclar Vivadent AG) and selectively layered with feldspathic porcelain (IPS e.max Ceram; Ivoclar Vivadent AG) to achieve the color match (Fig. 7).

The enamel was etched with 37.5% of phosphoric acid for 15 seconds, and a layer of dental adhesive (Optibond Solo Plus; Kerr Corp) was applied for 15 seconds, air dried for 3 seconds, and light-polymerized for 10 seconds. The veneers were etched with hydrofluoric acid (Vista Porcelain Etch Porcelain Etch Kit; Vista Dental Products) and silane (Monobond S; Ivoclar Vivadent AG). Translucent light-polymerizing resin cement (NX3 Nexus Third Generation; Kerr Corp) was used for the definitive bonding. Occlusion was evaluated and followed by intraoral finishing and polishing. Intraoral and extraoral images were obtained (Fig. 7). An occlusal device was provided for the patient with instructions to wear at night.

DISCUSSION

This clinical report presented a digital workflow (DSS) that enabled the clinician, patient, and dental laboratory technician to communicate effectively during treatment planning and to use the agreed-upon digital information to guide tooth preparation, the interim restorations, and the fabrication of the definitive porcelain veneers.

The use of digital software, such as the DSS (EGSolution), provides benefits for the esthetic rehabilitation of patients. It allowed digital, almost automatic, smile analysis and measurements and effective patient involvement in the design of the definitive restorations. It also simplified the conventional laboratory procedures through the selection of tooth molds from virtual tooth libraries that can be applied directly on the patient's facial images and served as an effective 2D previsualization tool. The option to mill trial restorations from the digital files and evaluate them in the patient's mouth is another advantage in patient communication.[7-9]

Digital software systems are not free of problems. They have limitations and require a learning curve. For example, dynamic occlusal analysis and 3D facial or dynamic scans and videos are not yet incorporated in most systems, and the use of third-party software is required to accommodate such features. Moreover, cost related to software purchase, updates, and hardware, as well as training, are limiting factors to the wider use of such technologies. Cost-effectiveness of a digital workflow depends on not only the ease of use of software itself but also the dexterity, skills, training, and experience of the user. Studies reporting on clinical

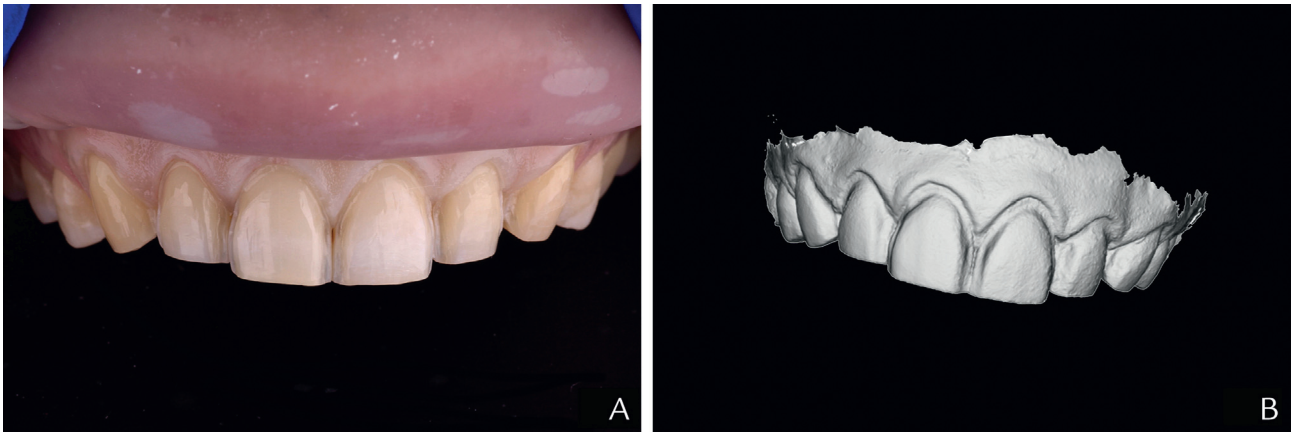

Figure 6. Digital scan. A, Final view of tooth preparation. B, Standard tessellation language file obtained from digital scan of preparations.

Figure 7. Definitive restorations. A, Exaggerated facial full-smile view. B, Intraoral view of teeth in maximal intercuspal position.

outcomes, patient-centered outcomes, and cost- and time-effectiveness of different digital workflows as compared with conventional workflows are necessary.

Lithium disilicate veneers were fabricated for this patient and then veneered on the incisal area with feldspathic porcelain to optimize the esthetics. While several materials could have been used, the use of this digital workflow necessitates the use of a prosthetic material, which can be milled or printed with available technology. Lithium disilicate has a record of successful clinical performance in terms of good marginal adaptation, lack of discoloration, gingival recession, secondary caries, or postoperative sensitivity, and high patient satisfaction.[10-16]

SUMMARY

This clinical report describes a digital workflow using the DSS software and CAD-CAM technology with milled lithium disilicate veneers to restore the maxillary anterior teeth of a 25-year-old man.

REFERENCES

1. Davis NC. Smile design. Dent Clin North Am 2007;51:299-318.
2. Matthews TG, Blatterfein L, Morrow RM, Payne SH. The anatomy of a smile. J Prosthet Dent 1978;39:128-34.
3. Simon H, Magne P. Clinically based diagnostic wax-up for optimal esthetics: the diagnostic mock-up. J Calif Dent Assoc 2008;36:355-62.
4. Magne P, Magne M, Belser U. The diagnostic template: a key element to the comprehensive esthetic treatment concept. Int J Periodontics Restorative Dent 1996;16:560-9.
5. Gurrea J, Bruguera A. Wax-up and mock-up. A guide for anterior periodontal and restorative treatments. Int J Esthet Dent 2014;9:146-62.
6. Pimentel W, Teixeira ML, Costa PP, Jorge MZ, Tiossi R. Predictable outcomes with porcelain laminate veneers: a clinical report. J Prosthodont 2016;25:335-40.
7. Coachman C, Paravina RD. Digitally enhanced esthetic dentistry–from treatment planning to quality control. J Esthet Restor Dent 2016;28:S3-4.
8. Cattoni F, Mastrangelo F, Gherlone EF, Gastaldi G. A new total digital smile planning technique (3D-DSP) to fabricate CAD-CAM mockups for esthetic crowns and veneers. Int J Dent 2016;2016:1-5.
9. Zanardi PR, Zanardi RL, Stegun RC, Sesma N, Costa BN, Laganá DC. The use of the digital smile design concept as an auxiliary tool in aesthetic rehabilitation: a case report. Open Dent J 2016;10:28.
10. Morimoto S, Albanesi RB, Sesma N, Agra CM, Braga MM. Main clinical outcomes of feldspathic porcelain and glass-ceramic laminate veneers: a systematic review and meta-analysis of survival and complication rates. Int J Prosthodont 2016;29:38-49.
11. Layton DM, Clarke M, Walton TR. A systematic review and meta-analysis of the survival of feldspathic porcelain veneers over 5 and 10 years. Int J Prosthodont 2012;25:590-603.

12. Peumans M, Van Meerbeek B, Lambrechts P, Vanherle G. Porcelain veneers: a review of the literature. J Dent 2000;28:163-77.
13. Zarone F, Ferrari M, Mangano FG, Leone R, Sorrentino R. "Digitally oriented materials": focus on lithium disilicate ceramics. Int J Dent 2016;2016:1-10.
14. Calamia JR, Calamia CS. Porcelain laminate veneers: reasons for 25 years of success. Dent Clin North Am 2007;51:399-417.
15. Wiedhahn K, Kerschbaum T, Fasbinder DF. Clinical long-term results with 617 Cerec veneers: a nine-year report. Int J Comput Dent 2005;8:233-46.
16. Sulaiman TA, Delgado AJ, Donovan TE. Survival rate of lithium disilicate restorations at 4 years: a retrospective study. J Prosthet Dent 2015;114:364-6.
17. Chochlidakis KM, Papaspyridakos P, Geminiani A, Chen CJ, Feng IJ, Ercoli C. Digital versus conventional impressions for fixed prosthodontics: a systematic review and meta-analysis. J Prosthet Dent 2016;116:184-90.

Corresponding author:
Dr Konstantinos M. Chochlidakis
625 Elmwood Avenue
Rochester, NY, 14620
Email: kchochlidakis@URMC.Rochester.edu

Acknowledgments
The authors would like to thank the Digital Smile System team (EGSolutions, Bologna, Italy) for the technical support and Nondas Vlachopoulos (AestheticLab, Athens, Greece) for his master dental technology skills.

https://doi.org/10.1016/j.prosdent.2018.10.012

Noteworthy Abstracts of the Current Literature

Patient-specific, risk-based prevention, maintenance, and supportive care: A need for action and innovation in education

Afshari FS, Campbell SD, Curtis DA, Garcia LT, Knoernschild KL, Yuan JC

J Prosthodont 2019 Mar 29 [Epub ahead of print]

Purpose. To develop a competency-based curriculum framework for prevention, supportive care, and maintenance for use in educational and patient care programs and to seek consensus on an overarching competency statement that embraces these critical learning and patient care concepts.

Material and methods. A preliminary survey of current preventive and maintenance practices in U.S. dental and prosthodontic programs was completed and summarized with quantitative analysis. The American College of Prosthodontists organized a one-day consensus workshop with 14 participants from various U.S. dental schools with diverse backgrounds to develop a curriculum framework. The curriculum framework was used in the development of a joint competency statement using an iterative, online consensus process of debate and feedback.

Results. The preliminary survey helped frame the initiative and identify potential educational needs and gaps. Consensus was achieved for a recommended competency statement: "Graduates must be competent in promoting oral health through risk assessment, diagnosis, prevention, and management of the hard tissue, soft tissue, and prostheses, and as part of professional recall and home maintenance." This competency statement complements the proposed curriculum framework designed around 3 domains-caries prevention, periodontal supportive care, and prosthesis supportive care-with a set of recommended learning objectives.

Conclusions. Commission on Dental Accreditation (CODA) learning standards do not outline patient-customized, evidence-based recall and home maintenance programs that highlight prevention of dental caries, periodontal supportive care, prosthesis maintenance, and patient education. The proposed competency-based curricular framework serves as an initial step in addressing student learning and patient care within the context of a recall system and home maintenance program while offering schools the needed flexibility for implementation within their curriculum.