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Case Report

Clinical Workflow of Two Different CAD/CAM Systems for Veneers Manufacture

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Abstract

Digital technology is improving dentistry by manufacturing restorations faster and easier. Veneers can be handcrafted fabricated by the dental technician or designed by software and fabricated by a milling machine. Currently, there are many scanners available in the market that are clinically acceptable for the fabrication of restorations. However, there have been no clinical reports comparing the clinical protocols of the two most frequently used software programs in the market. The aim of this article is to show the digital workflow of the two most common systems for the fabrication of CAD/CAM veneers.

Keywords: CADCAM, digital dentistry, esthetic dentistry, scanners, technology, veneers

Introduction

In the 1920's, Dr. Charles Pincus described a technique in which porcelain veneers were retained by a denture adhesive during cinematic filming. Unfortunately, the restoration was fragile, and it needed to be removed after filming because no adhesive system existed at that time for long-term attachment.[1] Since those first attempts of cosmetic restorations, many ceramic restorations and adhesive systems have been developed. The complex adhesive-porcelain veneer has shown to be very strong *in vitro* and *in vivo*, but the optimal bond is obtained when preparation is solely in enamel.[2] Because of that, conservative preparation is always the goal for a veneer restoration.[3] Currently, Laminate veneers are routinely used to restore teeth and to respond to the esthetic demands of patients.[4] While porcelain was the only available product in the market in the early days, companies have developed more types of ceramics such as lithium disilicate.[5-7] Ceramic restorations can be either conventional made by technician or machine milled designed with a 3D software.

Various direct and indirect techniques have been employed. Recently, through CAD/CAM technologies, improvements in laminate veneer fabrication have been possible.[8]

There are several advantages for the fabrication of ceramic laminate veneers processed by CAD/CAM systems.[9-12] First, restorations can be milled faster than those hand-crafted by the dental technician. After the digital design, a milled restoration can be made within a few minutes, whereas traditional casting or firing techniques can take hours for completion.[13] Moreover, the shipping process from the clinic to the laboratory and back to the dental office can take up to several days.

Digital scanning has become widely used to make impressions due to high accuracy, increased patient acceptance, and ease of entry to digital workflows.[8]

Subtractive techniques for the veneer fabrication can be solely performed by software and the milling machine.[14] After the prepared teeth are intra-orally scanned, the clinician can either scan a diagnostic mock-up or the software can provide tooth shapes and forms from its own library.[15,16] Because the teeth are scanned with the adjacent and opposing dentition, the

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software will provide the contour of final restorations that will match the interdental space and similar contours of the adjacent restorations.

Dental technology can provide higher accuracy than humans.[17,18] Human errors can be made in any of the many steps needed to manufacture veneer restorations using conventional techniques. After making the conventional final impression, the impression should be visually evaluated to find out if the margins were completely captured. Then, conventional pouring techniques also need several steps; first the correct measurement of ratio of water to die-stone, then pouring master casts without voids which could interfere with the definition of the margins. It has been claimed that all-ceramic restorations fabricated using chair-side scanners may have superior marginal fit and improved proximal contact compared with those fabricated using conventional impressions.[19] Last but not least, die trimming has to be performed very carefully due to the small areas to be defined. An experienced dental technician using magnifications is needed for this step due to its complexity.

Marketing is a key part for any dental office. Most of the patients find the use of robotic technology for their oral care is very appealing, and attracts more patients to that specific dental office. Because of that, novel dental technology is a type of marketing investment for the dental office.[20,21]

Cerec Sirona is a very common system. Dr. Mormann and Brandestini introduced the system in the late 1980s. The first basic concept had a two-dimension capability to only produce inlay restorations. The first crowns manufactured were in the 1994 still using a two-dimensional design. It was not only until 2003 when the software introduced the three-dimensional capacity to produce larger restorations up to three and four unit fixed dental prostheses.[22] Currently, the software is very advanced such that complex implant restorations can be scanned, designed, and fabricated within minutes.

Two graduate students in Denmark founded 3Shape in 2000. Currently, 3Shape has several products, including the intra-oral scanner, cone-beam computed tomography scanner, laboratory scanner, and several software solutions for the clinician and technician. In March 2017, the TRIOS 3 was introduced which is the latest scanner that connects via Wi-Fi to a laptop or traditional cart, eliminating the need for a connecting cable between the scanner wand and the computer. The scanner has special features such as Real Color Scanning, High-Definition Photo Function, and Digital Shade Determination. The software produces open STL files that could be compatible with any other company. 3Shape still does not have its own dedicated milling machines for in-office, chair-side restorations.[23]

Purpose

The purpose of this case report is to present two cases utilizing CAD/CAM systems for the fabrication of veneer restorations.

Case Reports

Clinical report 1

A 61-year-old female patient presented with a chief complaint of "I want to improve my smile". Upon examination, the patient was diagnosed with worn teeth, interdental spaces, and a reversed curve smile [Figures 1 and 2]. Diagnostic wax-up was performed following the patient's desired esthetic outcome [Figure 3]. The wax-up was then transferred to mouth using a silicone index to evaluate esthetics, phonetics, patient smile, occlusion, and overall patient comfort [Figure 4]. The smile analysis provided the need of improving teeth proportions. The patient approved the mock-up contours to be copied in the final restorations. Conservative teeth preparation was provided with horizontal depth grooves using a diamond bur [Figures 5 and 6]. Subsequently, prepared teeth were coated with a thin, opaque layer of white titanium dioxide powder (Cerec Optispray, Sirona Dental) to achieve uniform

Figure 1: Initial intra-oral frontal view showing interdental spaces, worn teeth and nonsymmetrical incisal embrasures

Figure 2: Initial intra-oral in occlusion

Figure 3: Diagnostic wax-up

scatter of the light that clearly defines the surface anatomy before being scanned (Cerec Bluecam) [Figure 7]. After that, a new diagnostic mock-up was placed in mouth, and again an opaque layer of titanium dioxide powder (Cerec Optispray, Sirona Dental) was applied and mock-up was scanned to create a bio-copy that would guide the final design of the restorations [Figure 8]. At the end of the appointment, the patient received provisional restorations based on the mock-up shape. The scanned images of the preparations and mock-up were merged to facilitate the final design [Figure 9]. Lithium disilicate blocks (IPS e.max CAD, Ivoclar Vivadent) were milled to fabricate the final restorations, (MC XL Milling Unit, Cerec Sirona) and then, they were glazed and polished preserving the line angles to maintain the contours. A dry try-in was performed to evaluate the fit and shape of the restorations, and the patient approved their placement. Preparations were cleaned with pumice paste (Pumice Preppies, Whip Mix) and soft rubber cup (Densco Prophy Cups, Henry Schein), followed by air sandblasting of teeth with water and 29-micron aluminum oxide particles (AquaCare Aluminum Oxide Air Abrasion Powder, Velopex). Total etch of the enamel surface was provided with 37% phosphoric acid (Total Etch, Ivoclar Vivadent) for 15 s, [Figure 10] and it was rinsed and gently dried with compressed air, followed by primer application (Premier, Variolink) and gentle removal of the excess with air. A light shade of adhesive (Variolink Esthetic LC, Ivoclar Vivadent) was applied to the intaglio surface of the veneer, seated on the prepared tooth, and light cured for 20 s (Valo LED (Light-Emitting-Diode), Ultradent) on the facial surface followed by the excess removal with floss in all interproximal surfaces, and another light cure of 20 s each on the incisal, mesial, facial, and repeated on the facial in each single tooth. After placement of all ceramic restorations, the oxygen inhibition layer treatment was provided with glycerine-based gel on the surfaces and light cured for 40 s (DeOx, Ultradent) [Figure 11]. The patient was pleased with the contours, shape, and shade of the lithium disilicate veneer restorations [Figures 12 and 13].

Clinical report 2

A 20-year-old female patient presented after completing the phases of a multidisciplinary dental treatment including

Figure 4: Diagnostic mock-up

Figure 5: Preparation guides on mock-up

Figure 6: Final tooth preparation

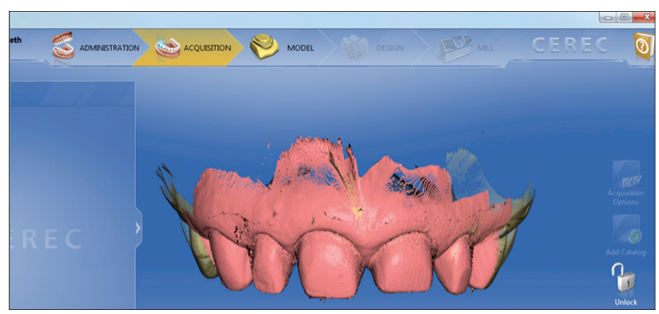

Figure 7: Tooth preparations scanned

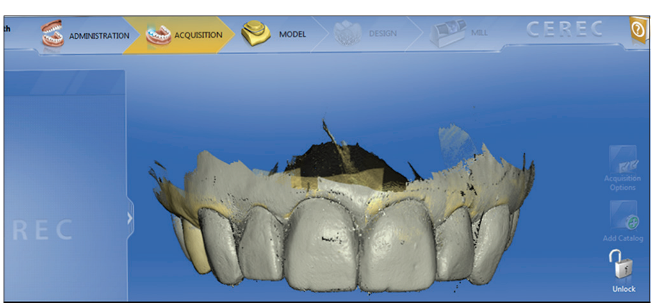

Figure 8: Diagnostic mock-up scanned

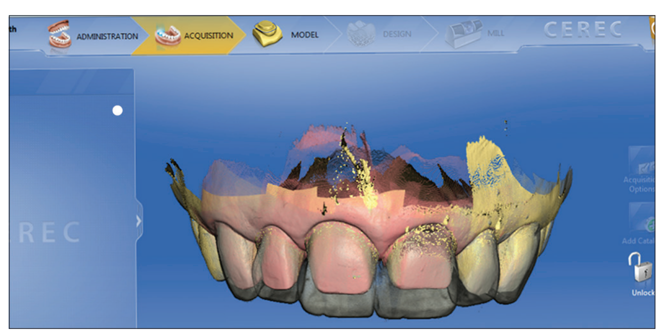

Figure 9: Digital images of mock-up and tooth preparation

orthognathic surgery and orthodontics. Beginning with diagnostic printed casts [Figure 14], the workflow describes the clinical and laboratory procedures for the enhancement of the esthetics of the maxillary anterior teeth in conjunction with multidisciplinary dental treatment by a periodontist and a prosthodontist.

The photographic analysis was performed [Figures 15 and 16] to assist in the initial evaluation. Diagnostic wax-up for teeth # 4–13 was made [Figure 17], and confirmed with a trial mock-up to refine esthetic parameters and to estimate margin location. A surgical guide was then fabricated for crown-lengthening surgery [Figure 18]. After healing, tooth-preparation was guided by a bis-acryl mock-up obtained from the additive wax-up using depth calibrated diamond burs. Reduction grooves were marked, and a chamfer bur was used to finish the preparation [Figures 19 and 20]. Soft-tissue management and marginal exposure were performed. An optical impression (Trios/3shape) of the prepared upper teeth, opposing mandibular teeth, and an interocclusal record were completed [Figure 21]. Esthetic shading was determined. One-piece milled CAD/CAM provisional veneers were fabricated (DWX-51D/Roland) from the wax-up scan and bonded on the teeth using a point acid-etch technique with flowable resin composite [Figure 22]. A "Prepreparation Scan" option of the patient-approved provisional served as reference for the definitive design [Figure 23]. Individual laminate veneers were milled from low translucency IPS e. max CAD (Vita A1)

Figure 10: Acid etching on teeth

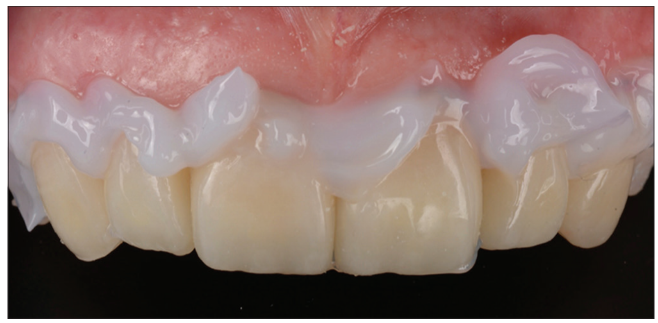

Figure 11: Oxygen inhibition layer

Figure 12: Final restorations

Figure 13: Final restorations in occlusion

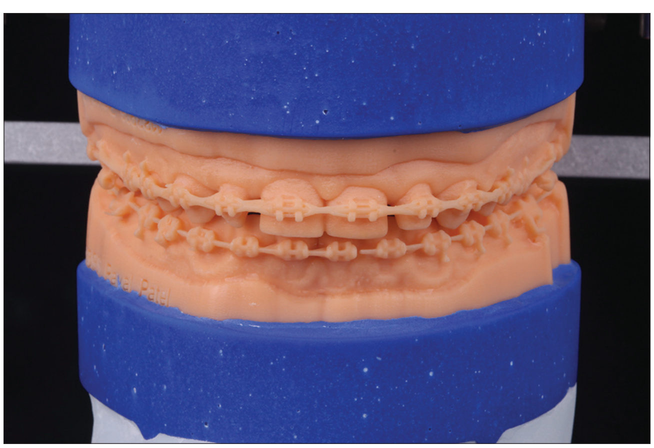

Figure 14: Printed diagnostic cast during orthodontic treatment

Figure 15: Initial situation after orthodontic treatment

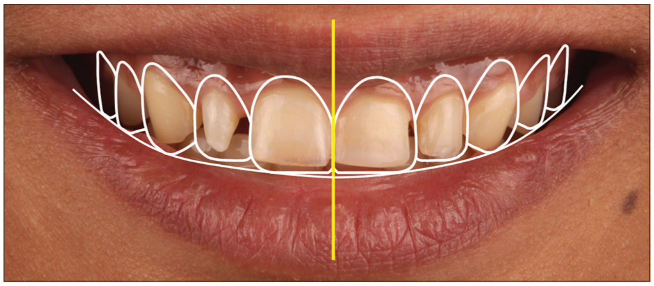

Figure 16: Digital smile analysis and final design

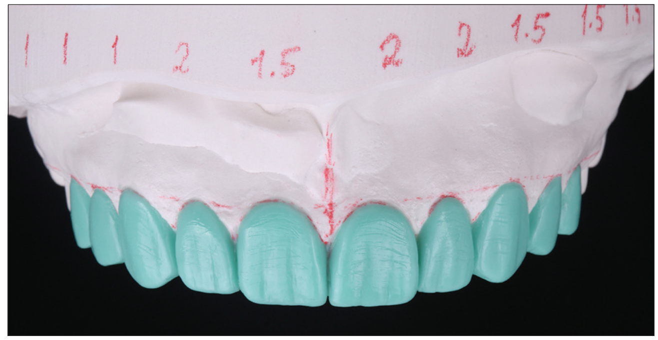

Figure 17: Diagnostic wax-up

Figure 18: Crown lengthening procedure to correct gingival discrepancies

Figure 19: Preparation guides on mock-ups

Figure 20: Final tooth preparations

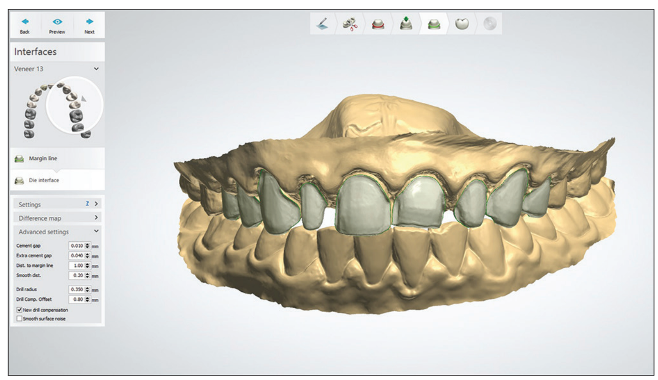

Figure 21: Digital impression

milling blocks (Ivoclar-Vivadent) by Planmill 50 (Planmeca). Master digital cast was SLA printed (Form2/Formlabs) to confirm marginal fit and proximal contact points of the veneers prior to delivery [Figure 24]. After final patient approval, laminate veneers were bonded using translucent light-cure resin cement (RelyX Ultimate, 3M ESPE, Shade A1), following manufacturer's recommendations, and cured using a LED curing light on standard setting. Occlusion in Maximum intercuspation position (MIP), protrusive, and laterotrusive movements were verified, and the patient was pleased with the contours, shape, and shade of the restorations [Figures 25 and 26].

Discussion

All-ceramic restorations have been widely used to restore the esthetic area due to their optical properties. These types of materials can be used for indirect method by processing with conventional laboratory techniques or by novel procedures using high technology.[24,25]

Computer-aided design and computer-aided manufacture of veneers can speed up the production of the final ceramic restorations. Intra-oral scanners prevent complex steps for final conventional impressions such as custom impression tray fabrication, using heavy and light body impression materials and the actual placement of loaded trays in the mouth for few minutes that is not a very enjoyable time for the patient. The fabrication of crowns with chair-side digital technology is not new for the clinician; however, the manufacture of highly esthetic and thin restorations may be a novel approach for them.[26]

Dental technician's assistance may not be needed in the entire production of this type of veneer fabrication; however, a qualified person with knowledge in the appropriate software may be needed if the clinicians prefer to invest his time treating

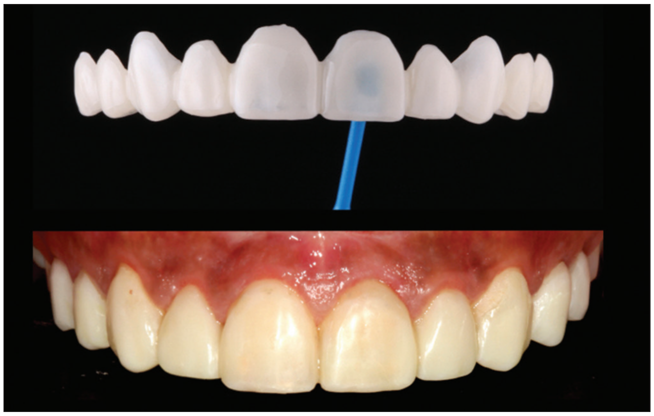

Figure 22: CAD/CAM provisional restorations

Figure 24: Printed master cast and final CAD/CAM lithium disilicate veneers

Figure 26: Final restorations

more patients. Digital dentistry is pushing conventional dental technicians to be more like a dental software technician, applying their dental and laboratory knowledge in the digital fabrication.

Many restoration materials are available in the dental market for CAD/CAM technology. These materials include lithium disilicate, zirconia, translucent zirconia, and composite.[27,28] For conventional press techniques, lithium disilicate and porcelain are the most common materials.[29] For a single veneer restoration, porcelain may be recommended since it could be hand-crafted using a variety of shades to match the polychromatic adjacent teeth.[30] For multiple veneer restorations, CAD/CAM technology may fulfill their needs since matching the adjacent teeth is not highly demanding as for a single one.

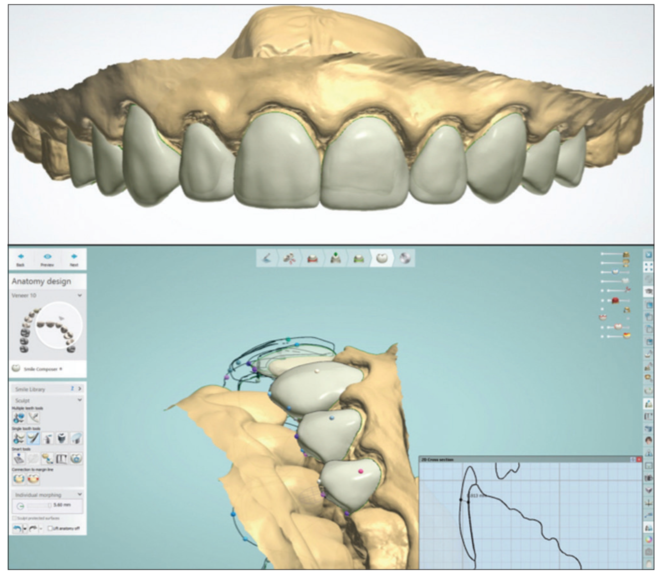

Figure 23: Designing of definitive veneer restorations

Figure 25: Final intra-oral view

Conclusion

CAD/CAM can be utilized to achieve patient esthetic desires and clinical expectations. Digitally designed and machine manufactured veneers can fulfill patient and clinician expectations, improve communication among the patient, clinician, and technician, and promise to enhance outcomes for all ceramic restorations.

Both systems utilized in this clinical report provided reliable intraoral scanner and digital design that can be milled for faster manufacture of veneers than conventional techniques. Trios is an open file system, meaning that veneers can be manufactured by any milling machine; on the other hand, Cerec is a closed system in which restorations can be milled only by its own milling machines. Cerec and Trios provide you the option to select the shade of adjacent teeth, thereby facilitating intra-oral shade matching. The two systems are constantly updated making the clinician's job easier than ever.

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Conflicts of interest

There are no conflicts of interest.

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