The Use of CAD/CAM Technology in Design and Manufacture of Thin Laminate Veneers

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Abstract

Porcelain laminate veneers are contemporary way of modifying tooth shape with minimal invasiveness toward hard dental tissue. With latest development of CAD software and CAM technology, it has become possible to mill thin veneers directly out of a CAM unit. The aim of this article is to show the use of CAD/CAM technology in the production of veneers, used for tooth form modification. A young female, with rudimented upper right second incisor asked for a non invasive form change. Teeth were scanned with intraoral scanner (Sirona, CEREC AC, Beinsheim, Germany). Using CAD software (version 3.8) a veneer has been created, using appropriate tools from the menu. Left incisor has been treated with a metal-free full crown. After finalization of the tooth design, data have been sent to the milling unit (Sirona, CEREC MCXL, Beinsheim, Germany). Veneer and a crown were milled out of a lithium-disilicate glass ceramic block (IPS e.max CAD, Ivoclar Vivadent, Schaan, Liechtenstein). Both restorations were adhesively cemented. CAD/CAM systems allow effective, precise and time saving dental treatment. Further development will increase indication range and susceptibility of the systems in the everyday's practice.

Keywords: CAD/CAM, dentistry, veneers.

1 Introduction

Digitalized dentistry enables efficient, fast, precise and error free production of fixed prosthodontics appliances. In recent years, it developed significantly into the major dental branch, currently used by the increasing number of dentists and dental technicians worldwide.

Computerized dentistry consists of three parts: 3D digitization, CAD (computer aided design) and CAM (computer aided manufacturing). 3D digitization transforms real model into a digital mesh of dots, and can be done via intra or extra oral scanning. CAM refers to a numerous number of software, that enable on-screen design and modification of selected restoration. Finally, CAM part is a milling unit, with 3 to 5 axis rotary instruments that mill out desired shape out of a preformed ceramic or composite block.

Minimal invasiveness and hard tissue preservation became increasingly important topic in contemporary dentistry. Cosmetic reconstructions often require irreversible tooth reduction. With latest modifications of ceramic materials, their mechanical properties enabled production of very thin, translucent restoration, used for cosmetic shape modification. This type of dental veneers can be done either in press or CAD/CAM systems. Press technology is considered as a classical approach, were dental technician produces stone cast out of an impression taken from the patient. Consequently, wax pattern is being created, invested and pressed in a specialized furnace. Even though described approach is relevant and used for decades, CAD/CAM offers significant improvements of this procedure. First, standard impression is not needed. Instead, scan of the patient mouth is being taken, using special intraoral scanner. Data have been transferred into the computer, where a virtual model of the patient teeth is assembled. Virtual designing is a matter of minutes, and manufacturing also requires some 15 minutes. As seen, CAD/CAM restoration can be finished within one patient’s visit.

Even though CAD/CAM restoration are made out of blocks, that are maximally three-layered (corresponding to dentin, enamel, and their interface), individualization is still possible, using special ceramic stains and shades. Such as optical effects create illusion of depth, contrast or opaque-ness.

2 Case study - application of CAD/CAM in design and manufacture of veneer

Female patient, 33 years old, came into the practice unsatisfied with the current appearance of her lateral incisors in the upper jaw (Fig. 1). Left one was devitalized, stained and exhibits a large palatinal filling with retentive metal post. On the contrary, right one was a vital tooth, but rudiment and positioned orally. The idea was to replace left incisor with a full crown, and the right one could be preserved by designing a non-prep veneer, adhesively luted to the labial tooth surface. In order to make a fast and reliable change in the appearance, CAD/CAM system was used (Sirona, Bensheim, Germany).

Fig. 1 Initial situation, rudiment right and stained left lateral incisor

After preparation of the left incisor, the optical impression has been done. To serve this purpose, intraoral scanner was used (CEREC AC scanner). This is a blue light emitting unit, that uses optical triangulation in order to digitalize real substrate. Wavelength of the light is 420 nm, and aqu-
racy is 19 µm. This camera exhibits certain modification compared to its predecessor. They relate to improved optical lens system and newly developed camera software. Those two components enabled more precise digitalization and elimination of the blurred images, that appear as a consequence of the motion either of the patient, or a therapist.\textsuperscript{10,11} Scanned images appear as a virtual on screen model (Fig. 2).

![Fig. 2 Scanned teeth as a virtual model](image)

CAD software (version 3.8) enables automated functions, that can easily be modified and corrected manually, if needed. First step is preparation line detection. With mouse movements, dots are positioned on the preparation line, circling the margin. Based on this input, a next step can proceed, in which initial tooth contour is suggested automatically. There are several morphological databases (young, adult, old, asian, etc.) that serve the purpose. Further, for this purpose, biogeneric relation was used.\textsuperscript{1,12} This function detects characteristics of the patient’s teeth, suggesting more individual tooth design (Fig. 3).

![Fig. 3 Left lateral incisor after CAD modeling](image)

Minor modifications of the tooth morphological appearance can be done with manual tools. In this menu, add, remove, smooth and other functions support individual tooth characteristics, or those demanded by a patient. Software can trim or remove virtual model, enabling clear visibility of the restoration. Software keeps minimal material thickness and also shows over contoured regions in different colours. After finalization of the veneer shape, it is locked and ready for milling.

Similar procedure was used in order to design contralateral, left second incisor. This tooth, however, has enough space for any kind or form variations. To create most appropriate tooth shape, special software function was used, called ‘correlation’. It, actually, mirrors selected form into its contralateral counterpart. Herewith symmetry was achieved, making teeth arch appear pleasant and attractive for the viewers (Fig. 4).

![Fig. 4 Correlation between left and right incisor](image)

Final outcome of the CAD designing can be seen in Fig. 5. CAD model is then sent to the milling unit (Sirona MCXL). The unit has two rotary milling instruments, and version for dentists is limited to single units production (inlays, onlays, crowns, veneers).\textsuperscript{13} Accuracy of the milling unit is 25 µm. Milling speed has been improved 60% with this unit, though it depends on the material used. For this purpose, lithium-disilicate ceramic material was a choice (IPS e.max CAD; Ivoclar Vivadent AG; Schaan, Liechtenstein, Fig. 6). Flexural strength of 360 MPa is sufficient for any kind of single unit restoration. Milling is done in a so-called blue phase, where material is in the meta-silicate stage. It offers faster milling, and prolongs life of the rotary instruments. Meta-silicate requires thermal treatment (crystallization) to achieve final disilicate stage. Crystalization is done in regular ceramic furnaces.

![Fig. 5 CAD model of the left incisor](image)

![Fig. 6 Milling unit with lithium-disilicate block](image)

After try in and some slight modifications, final colour of the restoration has been achieved with ceramic pigments (Fig. 7). Ceramic blocks can either be first crystallized and then individualized, or those stages can be done in a single step. If so, a special spray glaze is used.

![Fig. 7 Individualization of the milled crown](image)
Adhesive cementation with composite cements can also make subtle changes in final appearance, due to the colour characteristics of the selected cement (Fig. 8). Glycerine gel is applied before final polymerization, in order to achieve oxygen free surface. Final outcome in situ is shown in the Fig. 8.

3 Conclusions

Within this article the application of CAD/CAM technology in the production of veneers, used for tooth form modification, has been presented. For this purposes, a case study related to non invasive form change of young female’s rudimented upper right second incizor, has been used.

The results obtained in the framework of the presented study confirm the CAD/CAM technology in dentistry as a modern, contemporary and preferred way of manufacturing dental restorations either in a practice, or a dental laboratory. To emphasize the effect of this technology, one could refer to a saying that “after a first CAD/CAM crown has been made, dentistry will never be the same”.

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