

Review Article

Functioning of Chairside CAD-CAM systems

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Abstract:

Over the last fifty years ceramic in its various forms has been the material of choice for replacing lost tooth structure as its most natural look-alike replacement. Conventional forms of ceramic could not be casted directly on the die and required a metal substructure on to which ceramic veneering was done. This form of ceramic was called a metal ceramic restoration but it lacked the lifelike appearance and true shade matching for which the ceramic was introduced into dentistry. Further research in the field of ceramic as a dental prosthesis material led to the development of all ceramic restorations which had improved shade compatibility and better patient acceptance. This article summarizes about the chairside fabrication of all ceramic restorations.

Key words: CAD CAM, scanner, digital

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This article may be cited as: Parasher P, Tarun. Functioning of Chairside CAD-CAM systems. J Adv Med Dent Scie Res 2014;2(4):38-44.

Introduction

Regardless of the advanced state of the 300-year old technique of casting, each of its steps could induce error in the final casting. Until 1988, indirect ceramic dental restorations were fabricated by conventional methods (sintering, casting and pressing) and neither was pore-free. With the combination of optoelectronics, computer techniques and sinter-technology, the morphologic shape of crowns can be sculpted in an automated way. For in office fabrication of restoration we will require a direct CAD CAM machine. Direct/chairside CAD CAM machines have following components:

- A 3-D video camera (scan head)
- An electronic image processor (video processor) with memory unit (contour memory)

•A digital processor (computer) connected to,

•A miniature milling machine (3-axis machine)

Digital fabrication of restoration has common steps:-

- Computerized surface digitization
- Computer-aided design
- Computer-assisted manufacturing
- Computer-aided esthetics
- Computer-aided finishing

The last two stages are more complex and are still being developed for inclusion in commercial systems.

The Optical impression/ Computerized surface digitization

First select the desired shade then tooth is prepared and scanning of the preparation is done. Scanning of prepared tooth is done either with LED based or Laser based

scanners. In case of a LED based scanner a small hand held video camera with a 1cm wide lens (scanner) when placed over the occlusal surface of the prepared tooth, emits infrared light which passes through an internal grid containing a series of parallel lines. The pattern of light and dark stripes which falls on the prepared tooth surface is reflected back to the scanning head and onto a photoreceptor, where its intensity is recorded as a measure of voltage and transmitted as digital data to the CAD unit.



Figure 1: LED scanner



Figure 2: Powdered surface

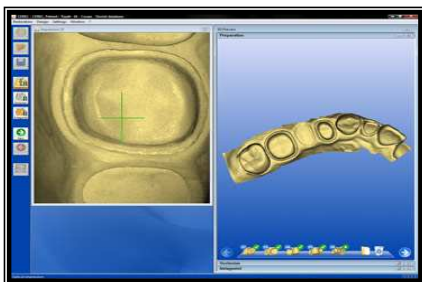


Figure 3: Captured image

In case of a laser based scanner a high speed laser takes digital scans of the

preparation and proximal teeth to create an interactive 3D image. Rapid scan allows automatic capture of digital images at the operator's preferred speed to scan in the mouth or extra orally on conventional impressions or models, all without powder. Newer laser based scanners can scan at subgingival level based on optical coherence tomography or OCT.

- At least 9 scans are required to produce the image. There are stabilizers present with the scanning device. If scanned image is correct it will appear in green color, if it is near correct it appears in yellow color but if scanned image does not meet the requirements software discards the image and shows it in red color.



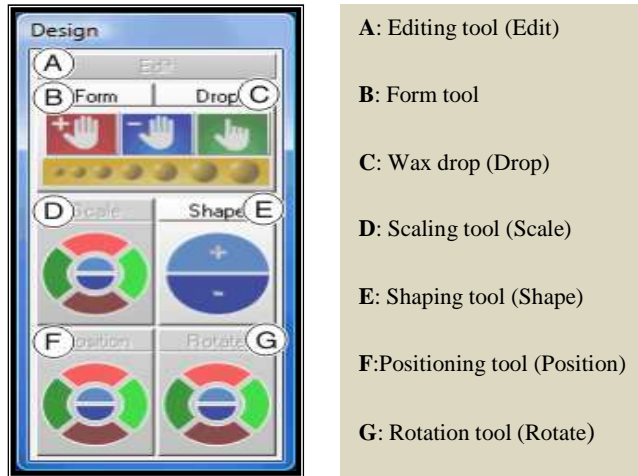
Figure 4: Laser scanner



Figure 5: Ice everything image

Designing the Restoration

The proposed restoration is designed by tracing frame lines on the optical impression (fixed image) which is projected onto the screen. Various tools are present for modifying restoration.

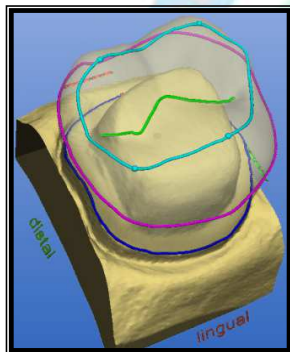


- A: Editing tool (Edit)
- B: Form tool
- C: Wax drop (Drop)
- D: Scaling tool (Scale)
- E: Shaping tool (Shape)
- F: Positioning tool (Position)
- G: Rotation tool (Rotate)

A: Editing tool (Edit)

Editing tools

- Click the "Edit" button to activate/deactivate the Editing function.
- LASSO tool with two options – automatic and manual is used for this.



- Colors of construction lines**
- Preparation margin, base line, gingival line – **BLUE**
 - Proximal contact line – **PINK**
 - Marginal ridge, labial/lingual line – **TURQUOISE**
 - Fissure, cutting edge or copying line – **GREEN**

Figure 7: Editing Tools

Form tool (Form)

By clicking the "Form" button, "Form" tool can be activated or deactivated



Figure 8: Apply Material



Figure 9: Remove Material

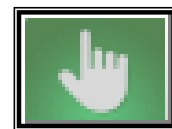


Figure 10: Blend Material

Wax drop (Drop)

By clicking the "Drop" button, activate or deactivate the wax drop function.

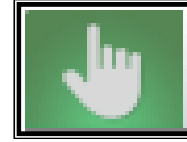
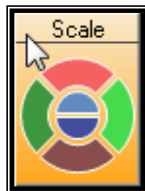


Figure 11: Apply Material **Figure 12:** Remove Material **Figure 13:** Blend Material

Clicking on the symbol activates the corresponding mode.

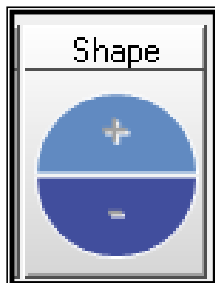
Scaling tool (Scale)



- By clicking the "Scale" tool, activate the scaling function. This function enables to scale a selected region.
- First select the region to be scaled by clicking one of the lines.

Figure 14: SCALE

Shaping tool (Shape)



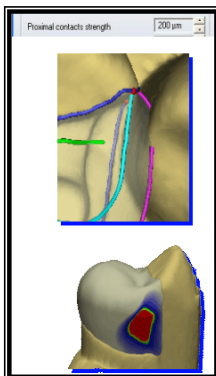
Functions like smoothen surfaces and apply or remove material can be performed with the "Shape" tool: Along and open line or inside a closed area.

To exit the "Shape" tool, click the highlighted button marked "Shape". On clicking the next button we get the options for detection for the margins

Figure 15 Shape

Proximal contacts

For checking the proximal contacts color indicators are there which indicate status of the contacts.



Red-Too tight contacts, yellow-needs finishing, green--perfect

Antagonist

Occlusal surface can be modified by activating the ANTAGONIST function. Color coding is same for proximal contacts. If dentist is satisfied with the design it can be sent for milling.

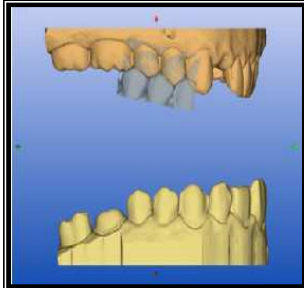


Figure 17: ANTAGONIST

Milling

In order to mill the restoration, the appropriate block is selected in accordance with the clinical situation. It not only determines the selection of the block in the required shade, but also the block size to be offered. Once the desired block has been selected, it is mounted in the CAM unit and the restoration is milled.



Figure 18: Milling Machine

Finishing of restoration

Carry out adjustments by grinding of restorations while they are still in their pre-crystallized (blue) state. Only use suitable grinding instruments, low rpms and light pressure to prevent delamination and chipping at the edges in particular.

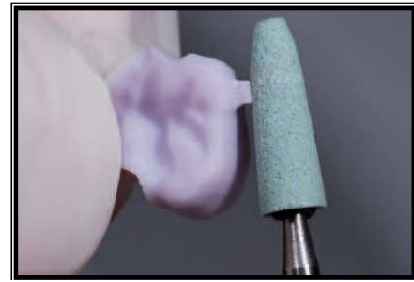


Figure 19: Smoothen out the attachment point



Figure 20: Try In of the Restoration

Always clean the restoration with ultrasound in a water bath or blast with the steam jet before crystallization. Residue of the milling additive remaining on the surface may result in bonding problems and discolouration during the Crystallization/Glaze firing. The characterizations and the glaze are applied before the crystallization to the “blue” restoration. Attach veneer, inlay or onlay on a temporary adhesive stick (OpraStick) before the glaze and the characterizations are applied. Alternatively, the restoration may be held also using diamond-coated tweezers. The ready-to-use shades and stains may be slightly thinned using Crystall./Glaze Liquid. However, the consistency should still remain pasty. Crystallization Tray and the corresponding pins must be used for the combination firing. Do not use a honey-combed tray.



Figure 21: Glaze Application to Onlay held with Optra stick



Figure 23: Etching Restoration for 20 Sec

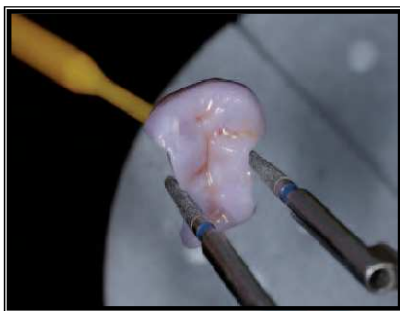


Figure 22: Characterizations and the glaze



Figure 24: Silanisation

A maximum of 6 restorations can be positioned on the firing tray and crystallized using the Combination firing. Final try-in of the restoration before cementation. Remove residue with ultrasound in a water bath. If additional characterizations or adjustments are required after crystallization, corrective firing is done.

Cementation

Glass-ceramics are etched with etching gel (5% hydrofluoric acid). Restoration is etched for 20 seconds. Subsequent silanization of the bonding surface with Monobond S generates a sound bond between the etched all-ceramic material and the luting composite.

The new light-curing veneer is especially indicated for the adhesive cementation of veneers. This material allows the user to increase or decrease the brightness of the ceramic restoration due to a special shade concept.

From simple restorations to the fabrication of three unit bridges chairside CAD CAM technology has come a long way. It has inspired many new technologies and newer concepts in the dentistry to make it 21st century dentistry. It is the cost that is mainly acting as deterrent for this technology to become a huge success. No automated system currently offers the flexibility with regard to restoration types and material choices that is possible with traditional fabrication methods. An emphasis on intraoral data acquisition scanners and digitizers is likely. This could lead ultimately to the elimination of impressions and stone models. It is likely that future digitizers or scanners will be more robust, facilitating accurate data capture despite the differences in foundation restorations within teeth, as well as differences in saliva and, perhaps, soft tissue. This means that data pertaining to the prepared, adjacent and opposing teeth

could be sent directly to a CAD/CAM system without being interpreted by a technician or clinician. CAD software is relatively mature and probably will not change dramatically. However, likely enhancements may include a simpler user interface and integration of virtual articulators, which would facilitate automatic design of the occlusal surface.

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