



The Use of CAD/CAM Technology to Educate Students in the Simulation Laboratory and in Clinical Settings

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Abstract

Objective

1. Utilizing available CAD/CAM technology, the captured 3D image allows students to better visualize, self-critique and improve their preparations on typodont teeth in the simulation laboratory prior to instructor input.
2. Through increased utilization of the CAD/CAM technologies in the prior described learning model, students are able to take a digital impression, design, mill and cement a restoration in one single visit in a group practice setting

Introduction

Many dental students find it challenging to prepare artificial teeth in a manikin head. Students at New York University College of Dentistry are offered state of the art technology to aid in self-assessing how to properly prepare teeth. As part of the second year curriculum, the student doctors learn how to prepare inlays and onlays on typodont teeth in the simulation laboratory. Preparations are evaluated for criteria like tapered proximal walls, flat pulpal and braking contact, proximal boxes, internal line angles or damage to adjacent teeth. These criteria are easy for the experienced clinician to visualize and assess for quality but for the student it is often difficult to visualize. There are multiple scanning technologies available to visualize (e.g. hand held intra-oral cameras) which can be utilized in routine practice to provide a surface image but it is not 3 dimensional and several for evaluating the quality of the preparation (e.g. KaVo PREPassistant® and DentSim Ltd™) utilize 3 dimensional technologies that are directed only at the quality of preparations in a laboratory setting.

CAD/CAM technology, though commonly utilized for the capture of tooth preparations and eventual manufacture of the restoration allows the students to take a digital picture of prepared teeth, render a three dimensional image and then to evaluate their work. The fact that the same system is utilized in a clinical setting where the student design and mill a restoration in one single visit enhances this pre-clinical learning experience as the training is directly related to improving student performance in the clinical environment.

Method

Using the CAD/CAM technology, students are able to digitally take an impression of a tooth they prepared and view a virtual cast magnified 12 times. The students are able to rotate the cast 360 degrees. Evaluating their work and improving their skills with the help of a trained and calibrated faculty. The students learn how to design different restorations, they become familiar with the milling process as well as fitting the restoration and the steps of permanently cement the restoration.

As the student progresses to the clinic He/she will treat patients in their respective group practices with the same procedures practiced on typodont teeth in the Simulation laboratory during the third and fourth years he/she will perform the same procedures on patients that would benefit from this technology. The acquisition unit is used chair side for taking the digital impression after the preparation has been approved by the calibrated faculty. In most challenging cases, an image of the preparation can be exported on line to the course director, who can critique it and suggest any modifications that may be necessary. Changes can then be made to either the preparation or the design of the restoration before the procedure is finalized and sent to the milling unit. The restoration is then fitted and bonded to the tooth structure at the same visit.



Conclusions

The magnified image of a tooth preparation on the monitor of the acquisition unit helps the student evaluate their preparation and improves their skill levels in tooth preparation. The student learns how to prepare an indirect procedure take a digital impression, design it using the skills learned previously, mill the restoration and cemented in one single visit.

1. Introduction

In the teaching model at New York University College of Dentistry, students are exposed to restorative procedures, first in the lecture, then in the laboratory and when they have demonstrated competency, they are permitted to perform on patients under the supervision of faculty. The laboratory is where students have a hands-on experience on artificial teeth and it represents the first chance they have to apply didactic knowledge as they perform a dental procedure. Evaluating the preparations on artificial teeth is traditionally done by faculty with a standard mirror, explorer and periodontal probe. The fine details of an acceptable tooth preparation versus a poor one are not always obvious to students, most of whom have no experience. Showing the student a perfect preparation is not always the best way for them to improve their own preparations. The camera used in the CEREC CAD/CAM system may be used to help students evaluate their own preparations on their own and with supervising faculty (Figure1&2). This helps them see their own work, magnified at 12X and much better visualize the details of their preparations that may not be as obvious in the artificial mouth.(Figure 3) CAD/CAM systems (computer-aided design/computer-aided manufacturing) use an optical impression and computer-directed milling of the indirect restoration [1-2].

2. Methods

The introduction of CAD/CAM systems and their potential to produce complex indirect restorations in one visit has evolved to include use in fixed and implant prostheses. New York University College of Dentistry (NYUCD) has made CAD/CAM training an integral part of its curriculum since 2005. It is taught as part of the Esthetic Dentistry Course, starting in the second year and is utilized extensively in the clinical facility fabricating hundreds of restorations annually. NYUCD currently limits the use of the CEREC CAD/CAM unit to inlays, onlays and single crowns.

As part of the second year curriculum, the student doctors learn how to prepare inlays and onlays on artificial teeth in the simulation laboratory. There are 3 steps: 1, the optical image 2, Designing the restoration and 3, milling and cementing the restoration

The laboratory session begins with a faculty demonstrating the whole procedure. That includes taking a digital impression, designing at least two restorations on an acquisition unit at the podium. Each student has his/her own monitor displaying all the steps (Figure3).

With the use of the CEREC acquisition units all students are trained to take a digital impression of their own work, this optical impression is displayed on the computer monitor, magnified twelve time, as a virtual model. The 3-dimensional image may be rotated for best viewing of the preparation from all sides. The image may be saved and transmitted for later viewing and analysis [2-3-4].

This exercise can be repeated several times by the students with faculty supervision until competence is attained. Students are free to capture images of all preparations and utilize this is instrument for self-assessment of their preparations.

As part of the D2 Esthetics curriculum at New York University College of Dentistry, students are taught to self-assess and evaluate their work utilizing CAD/CAM technology. Students create onlay preparations on their typodont teeth and are instructed to evaluate their own work using a periodontal probe, intraoral mirror, and a Self-Evaluation form which includes the following criteria pulpal depths, axial depths, and isthmus widths, Proximal embrasures, Tapered walls, damage to soft tissue and damage to adjacent teeth. After completing the Self Evaluation form based on their observations, the students are instructed to take an optical impression of



their work using CAD/CAM technology and evaluate their work a second time using the same form with the CAD/CAM machine as an adjunct. By using the CAD/CAM machine (Figures 1&2) that create a virtual cast magnified 12 times the actual size of the prepared tooth. Students are able to cut away adjacent teeth and virtually look at their preparation, rotating it 360 degrees. Students are also able to precisely measure the dimensions of their preparations. This isolation and measuring technique allows the students to visualize their preparations from all aspects, including interproximal regions, with to see the areas of their preparations that needed improvements. Using the information they gather from the CAD/CAM analysis, students are able to better analyze and visualize their preparations and improve on their quality of work. (Figure 1&2)

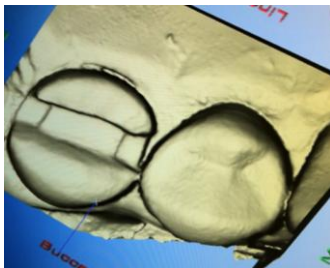


Figure 1.

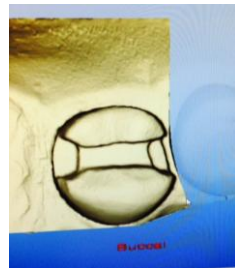


Figure 2.

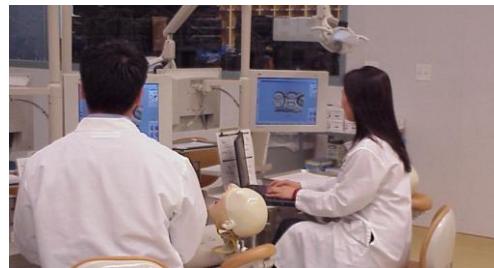


Figure 3.

3. Clinical Application

As the students progress to clinical patient care during their second, third and fourth years, they will treat patients in their respective group practices utilizing the same core dental procedures. These procedures have been practiced in the pre-clinical environment on typodont teeth in the Simulation laboratory. After a student's preparation has been reviewed by the calibrated course faculty, the CEREC acquisition unit is used chair-side for taking the digital impression and designing the restoration. The magnified image is discussed with the faculty so the student can better understand the tooth preparation and the designed restoration (Figures 3). In addition an image, of the whole procedure, can also be transmitted online to the course director, who can provide additional critique and suggest any modifications that may be necessary. The remote image evaluation can also be utilized when the course faculty are unavailable to aid in receiving feedback by transmitting the images to the course faculty through email. This technique can actually be utilized for any type of preparation regardless of whether a final computer assisted design restoration was to be provided. Changes can then be made to the design of both the preparation and restoration design before the restoration is finalized and sent to the milling unit. [5-6] The restoration, made of prefabricated ceramic blocks, is inserted in the milling chamber and milled in approximately 10 minutes, is tried in the patient's mouth bonded to the tooth structure at the same visit (Figure 4&5)[7]

The curriculum at NYUCD establishes competence in all aspects of general restorative dentistry including the preparation, design, fabrication and cementation of CAD/CAM fabricated restorations. Along with standardized procedure techniques, students gain exposure to more modern digital techniques. Introducing students to digital dental technology for routine utilization in the pre-clinical environment provides students with a broader scope of treatments, and makes them more aware for future advances in digital adjuncts for dentistry. The patient population at NYUCD benefits by making it possible to complete their necessary treatment more efficiently and more conservatively



Figure 4



Figure 5

4. Discussion

The curriculum at NYUCD establishes competence in all aspects of restorative dentistry as practiced by a competent general practitioner. Digital CAD/CAM technology has become a standard of care in many general practice's. It is often difficult to find adequate numbers of clinical cases for students to become comfortable with independent practice. Utilizing the computer assisted image capture during routine pre-clinical teaching allows the students to become better self-evaluators and at the same moment better clinicians. Utilization of the computer assisted image capture allows 3-dimensional imaging. Students utilizing these images for evaluation of the preparations have a better view and perspective as well as the image is easier for group discussion of the preparation. Just as a tooth preparation is not easy to learn and requires practice, the digital capture of the preparation is not easy. Learning to effectively capture these images requires both training and then experience. Utilizing the digital capture along with standardized preparation techniques, students gain exposure to more modern digital techniques. Introducing students to digital dental technology provides students with a broader scope of treatments, and makes them more aware for future advances in digital adjuncts for dentistry. The patient population at NYUCD benefits by making it possible to complete their necessary treatment more efficiently and more conservatively.

5. Conclusions

The utilization of CAD/CAM image of a tooth preparation in the helps the student evaluate their preparation and improves their skill levels in tooth preparation. The student learns how to communicate more effectively with faculty regarding preparation design, and make adjustments to preparation without necessitating another visit.

Figure 1: Ideal Preparation

Figure 2: Virtual Cast trimmed on both Mesial and Distal Surfaces

Figure 3: Student watching a procedure on their viewer in Simulation Lab

Figure 4: Upper left molar before preparation

Figure 5: Upper left molar after insertion

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