Short Communication

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Beyond Digital Margins, Helping Students Develop Visual and Thinking Skills with CAD/CAM

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Abstract

Computer technology and three-dimensional virtual image review ability enhances the student's understanding on the principles of preparation, temporization and cementation. Tooth colored restorations and the basic fundamental parameters of depth, definition of margins, interproximal contacts and occlusion are explained and discussed. The captured images are currently being utilized in an educational capacity in both the pre-clinic and clinic settings. The student is able to self evaluate and develop virtual visual outcomes. With CAD/CAM technology, beyond and within digital margins of the "tools" function, students have the opportunity to test their understanding of concepts, principles, and apply them.

KeyWords Tools Function, Cerec, CAD/CAM, Optical Images

Objectives

To teach students how to navigate the tools feature on CAD/CAM to design and generate tooth colored restorations, and to develop student self-assessment and critical thinking skills

Introduction

Since its introduction in the 1980's Computer Aided Design /Computer Aided Manufacture continues to enrich teaching and improving student's skills and dental practice¹. Advances in technology and software have made CAD/CAM an excellent instructional tool that is being utilized in dental school education. Computer technology offers students enhanced learning experiences. The

three-dimensional image review enhances the student's understanding on the principles of preparation, provisionalization, and cementation. Detailed lectures describing tooth preparation are given in pre-clinical and clinical sessions. Restorations, parameters of depth, definition of margins, interproximal contacts and occlusion are explained and discussed both in preclinical simulation lab and clinical technique lectures. Multiple software systems are taught and discussed in pre clinic lectures. In clinic and pre-clinical situations by utilizing CAD/CAM technology, students have the opportunity to test their understanding. This method of teaching leads to integrative assembling of information, which provides greater clarity and understanding. Experiential learning provides students with more challenging and engaging opportuni-

ties to learn, which later leads to greater proficiency in skill development. The ability for the student self-evaluate utilizing 3-D imaging enhances the entire learning experience. With indirect tooth colored restorations on typodont teeth students learn to become familiar with digital impressions. Students self assess their preclinical work in the presence of faculty familiar with the software. In third year and fourth year, students self evaluate, with faculty specifically trained in the software. Students can then fabricate direct tooth colored restorations on their patients.

Digital technology is the future of dentistry^{2,3,4,5,6}. Digital impressions and virtual models are more accurate, the provisionalization step is not required, and the restoration can be inserted in a single visit. CAD/CAM eliminates many human errors, reduces treatment time and stress to the patient. Cerec® CAD/CAM has been in use at New York University College of Dentistry since 1991. The three dimensional features offered by virtual models permits the student the ability to self evaluate and illustrate the outcomes

METHODS

Captured digital images are currently being utilized in an educational capacity in both the pre-clinic and clinic settings. In order for the student to master the technology, the following phases must be understood: In the Administrative phase, the student doctor's initials and the tooth number is recorded so the patients' identity is protected. The type of restoration is recorded, this is either a crown, inlay/onlay or veneer. Then the design mode is selected, which is either biogeneric copy or biogeneric individual. In "copy" mode the anatomy and contours of the pre prepared tooth are duplicated, in biogeneric mode the software available will aid in the final restoration's fabrication. This information is then saved. In the Acquisition phase, a digital impression is taken of the prepared tooth as well as the adjacent teeth. A digital image is also taken of the opposing arch. A digital impression of the upper and lower arch in centric occlusion is also needed. The images are then reflected on the monitor of the acquisition unit. In the Model phase, you trim the model, draw the margin, and define the insertion axis. The preparation can be evaluated for undercuts. The virtual model is trimmed to show the prepared tooth and can be magnified 30 x its original size. The virtual model can be rotated 180 degrees, to make it clearer for the student doctor to properly trace the margin of the prepared tooth. In the Design phase, the student sees a proposed restoration generated according to all the previous digital images. There are multiple icons here, which include view, tools, display objects, and analyzing tools. The icons featured help navigate and facilitate the design of the restoration. The view icon displays each surface, one at a time: occlusal, mesial, distal, buccal and lingual. The display object portrays the upper and lower arch individually, and shows the trimmed model and the proposed restoration. Faculty and students view different surfaces of the restoration visualizing details of the preparation. The tool icon is the only icon that can change the restoration. It is used to add, remove and modify contours. It can rotate and move the restoration in any position. This is the only icon that can create form and shape. The analyzing tools are very helpful in teaching by demonstrating where a tooth may be over prepared or under prepared, by showing the thickness or lack

of depth on a virtual restoration. Proximal and occlusal contacts are also visualized. These features offer students a hands-on opportunity to view the model and restoration with a 3D capability. The model can be maneuvered and rotated. This makes the restoration details easy to view, enhancing student understanding. Learning takes place when students use didactic information from basic dental anatomy and integrate foundation knowledge by application of the analyzing icons. By utilizing the "tools" function, the student can create and/or correct contacts, contour, and occlusal anatomy. Adjustments can also be made if any imperfections and deficiencies are noted. The last step is the Mill phase. The student/faculty chooses the proper material and tooth shade prior to the milling phase. The information is then exported wirelessly from the acquisition unit to the milling chamber.

DISCUSSION

CAD/CAM Dentistry is one of the fastest growing fields of Dentistry^{2,3,4,5,6}. There are multiple educational benefits of using this technology. Digital images, virtual models, and demonstrations on a large screen have become a very useful tool in dental education. Concepts of occlusion, anatomy and spatial relations are used and visualized as a restoration is designed and readied before the milling process. Demonstrations are used to offer students suggestions and to teach them how to use the icon features for critical self-reflection, self-assessment capability, and to help broaden their understanding by improving visual and thinking skills.

Students concurrently learn and have hands on participation on traditional impression techniques, pouring, and articulating models in centric occlusion. Hands on laboratory procedures are also taught so students understand the manual and artistic requirements of laboratory methods. Today dental laboratories are keeping up with this technology. They also use CAD/CAM to fabricate restorations from instructions digitally imported from practitioners. The option exists to send instructions wirelessly to mill a restoration chair side or to send it digitally to your dental laboratory^{4,6}.

CONCLUSION

Broader visual and thinking skills are a result of self assessment and evaluation of restorations in both a preclinical and clinical setting with the aid of faculty trained in the software.

Learning is improved when foundational knowledge is integrated with hands on experience in a pre-clinic simulation. With CAD/CAM digital images are taken of plastic teeth on a typodont model. Actual clinical cases are also utilized as teaching aids. This can better prepare students for their first attempt at milling a restoration on an actual patient. With a strong foundation knowledge of dental anatomy, students are equipped with the information they need to prepare and restore teeth, taking account of the tooth's morphology as well as the anatomy of adjacent and opposing teeth. Ideal dental anatomy of each individual tooth is included in the CEREC® software^{3,5}. "Ideal" is not always the case in treating patients. Student doctors should be able to alter contour, contacts and occlusion depending on individual patients' needs, age and existing dentition. Digital technology proves to be the future of Dentistry^{2,3,4,5,6}. Having the students trained in the basic and foundational knowledge will help them out in their future

career to perform state of the art Dentistry⁴.

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