CAD/CAM

Chairside CAD/CAM Technology: A Positive "Disruption" in Dentistry

Walter G. Renne, DMD, *Guest Editor*

A new generation of chairside systems is enabling CAD/CAM dentistry to become more mainstream. Providing unprecedented ease of use, accuracy, and speed in restorative dentistry, today's digital technology offers meaningful advantages over conventional techniques.

With the introduction of a new generation of chairside computer-aided design/computer-aided manufacturing (CAD/CAM) systems, what was once considered a niche technique for dental enthusiasts has rapidly transformed to become a standard of care. These new digital systems allow for unprecedented ease of use, accuracy, and speed, and enable clinicians to provide better services and care for patients.

Many of the new CAD/CAM dentistry systems that have hit the market in the past year represent a significant leap ahead of past systems, even to the point of surpassing conventional elastomeric impressions in terms of not only accuracy and ease, but also final product quality. CAD/CAM will likely become even more mainstream in 2014, because the scanning technology and design software has advanced to where it is now truly an innovation that causes clinicians to change how they think, behave, conduct business, and treat patients. The author refers to CAD/CAM as a "disruptive innovation," in that it is displacing an existing procedure or service with something new, more efficient, profitable, and worthwhile.

Improved Impressioning

In the past a digital impression didn't really provide any true advantage over a conventional impression because of the need for expensive powders, difficult and time-consuming imaging, and the fact that no meaningful extra information was captured beyond what can be gained with a traditional impression. Now, however, with new scanning technology there is a significant advantage in working on a modern digital scan compared with a poured model. The newest generation of digital models is not only significantly faster compared to a physical impression, but they also contain a vast amount of additional useful data. For example, many systems overlay a color effect or fuse high contrast black and white photographs on the model that make margin-marking clear and easy. This extra information alone has propelled digital dentistry into a new age, in addition to its other advancements such as powderless video speed imaging, automatic articulation, intuitive design software, bridges, implant abutments, and STL file export. Indeed, CAD/CAM has progressed substantially within the past year.

Return of the Partial Coverage Restoration

In the author's practice, the conservative single-visit CAD/CAM ceramic onlay restoration has made the large composite filling obsolete. Recent advances in chairside CAD/CAM systems have enabled quality lithium-disilicate or nanoceramic onlay restorations to be completed from start to finish in less than an hour and for a reasonable cost to the patient ($500). In the author's experience, this type of restoration is less stressful, faster, and easier than performing a quality direct resin restoration. Moreover, current direct resins simply do not have the long-term durability compared with CAD/CAM, and problems can become more pronounced as the direct resin becomes larger in size.[1-5] Nevertheless, resin-based composite (RBC) has remained the most common dental restorative material used. Posterior RBC restorations have a higher incidence of recurrent caries and need replacement more often compared to older alternatives such as amalgam restorations.[1,3-6] While a resin filling lasts an average of about 6.5 years, amalgam fillings have an average lifespan of 11 to 12 years, and ceramic onlay restorations offer a greater than 90% success rate at 10 years.[2,7-11] After 8 years, the failure rate for large posterior RBC restorations was 50% greater than amalgam restorations.[9] Furthermore, recurrent caries incidence is 3.5 times higher in RBC restorations than high-copper amalgam (HCA) restorations.[1]

In contrast, the ceramic onlay is an extremely durable restoration.[9-11] One study followed 547 posterior restorations and concluded the survival of onlays to be 92.4% at 12 years, with bruxism not negatively impacting survival; location also did not negatively impact survival.[8] Posselt and Kerschbaum followed 2,328 CAD/CAM restorations and the Kaplan-Meier projected survival was 95.5% at 9 years.[10] Average survival rates for IPS Empress (Ivoclar

Walter G. Renne, DMD

Assistant Professor, Division of Restorative Dentistry, Department of Oral Rehabilitation, Medical University of South Carolina College of Dental Medicine, Charleston, South Carolina; Private Practice, Charleston, South Carolina

Vivadent, www.ivoclarvivadent.com) inlays and onlays was found to range from 96% at 4.5 years to 91% at 7 years.[11] These impressive survival rates will likely become even higher with the newer generation of high-strength ceramics such as lithium disilicate.

Better Crowns and Bridges

CAD/CAM technology enables the clinician to fabricate restorations that fit as well as or better than laboratory-fabricated restorations. For example, a study of ceramic onlay restorations compared CAD/CAM restorations to laboratory-pressed restorations and found that the CAD/CAM restorations had better marginal fit.[12] Four-unit fixed partial dentures (FPDs) fabricated using a digital intraoral scanner were found to have better fit than restorations fabricated on the same cases using conventional impression techniques.[13] In another study, clinicians evaluated over 117 cases where two restorations were made—one by CAD/CAM and the other by a lab—and were asked to choose which one they thought was better. Blind to which crown was which, they chose the crown made digitally 68% of the time.[14]

CAD/CAM's high level of accuracy and predictability combined with a new generation of materials that have equal or better success than porcelain-fused-to-metal restorations has fueled the current digital revolution. Gehrt et al followed 104 e.max® (Ivoclar Vivadent) crowns in 44 patients and found the survival rate for all restorations was 94.8% after 8 years of clinical service, with location not significantly impacting survival rate.[15] Similarly, in a 10-year study Kern et al found three-unit FPDs made from monolithic lithium-disilicate ceramic showed 5- and 10-year survival and success rates that were similar to those of conventional metal-ceramic FPDs.[16] This type of clinical success coupled with the speed and power of new scanners and design software allows larger cases to be easily and predictably done in a single visit.

Simplifying Implant Treatment

CAD/CAM technology simplifies every aspect of implant treatment: the treatment planning, placement, and restoration. The merging of cone beam data with that of an intraoral scan to generate a truly restorative-driven treatment plan lessens the stress of implant therapy, while also helps the clinician explain the process to the patient. Furthermore, custom surgical guides can be milled from this combined data, allowing for a higher level of predictability. Once placed, fabrication of custom zirconium or lithium-disilicate implant abutments is easily achievable, as is making a final impression from a multitude of scanning abutments, further simplifying the process. This along with laboratory precision-milled titanium bars and zirconium "all on 4" prosthetics is only achievable with modern CAD/CAM technology.

Future Is Now

CAD/CAM has been established in many universities as the standard of care. At the Medical University of South Carolina College of Dental Medicine, students have access to numerous CAD/CAM systems and begin their freshman year learning digital dentistry in dental morphology utilizing powerful computer tools to virtually wax teeth. Assessment of student work has been completely revolutionized through use of computerized evaluation software, which employs 3-dimensional (3-D) surface mapping technology that displays any deviations from the ideal as color-coded errors. For second-year dental students, an entire course is dedicated to chairside CAD/CAM, teaching 70 hours of material on digital dentistry. Before arriving at the clinic, each student will have scanned more than 100 quadrants. Even RPDs are done digitally at MUSC.

Indeed, digital dentistry has matured past being a "niche" market to become one of the most "disruptive innovations" the profession has seen.

REFERENCES

1. Bernardo M, Luis H, Martin MD, et al. Survival and reasons for failure of amalgam versus composite posterior restorations placed in a randomized clinical trial. *J Am Dent Assoc*. 2007;138(6):775-783.
2. Christensen GJ. Should resin-based composite dominate restorative dentistry today? *J Am Dent Assoc*. 2010;141(12):1490-1493.
3. DeRouen TA, Martin MD, Leroux BG, et al. Neurobehavioral effects of dental amalgam in children: a randomized clinical trial. *JAMA*. 2006;295(15):1784-1792.
4. Levin L, Coval M, Geiger SB. Cross-sectional radiographic survey of amalgam and resin-based composite posterior restorations. *Quintessence Int*. 2007;38(6):511-514.
5. Simecek JW, Diefenderfer KE, Cohen ME. An evaluation of replacement rates for posterior resin-based composite and amalgam restorations in U.S. Navy and marine corps recruits. *J Am Dent Assoc*. 2009;140(2):200-209.
6. Soncini JA, Maserejian NN, Trachtenberg F, et al. The longevity of amalgam versus compomer/composite restorations in posterior primary and permanent teeth: findings from the New England Children's Amalgam Trial. *J Am Dent Assoc*. 2007;138(6):763-772.
7. Mjör IA, Dahl JE, Moorhead JE. Age of restorations at replacement in permanent teeth in general dental practice. *Acta Odontol Scand*. 2000;58(3):97-101.
8. Beier US, Kapferer I, Burtscher D, et al. Clinical performance of all-ceramic inlay and onlay restorations in posterior teeth. *Int J Prosthodont*. 2012;25(4):395-402.
9. Collins CJ, Bryant RW, Hodge KL. A clinical evaluation of posterior composite resin restorations: 8-year findings. *J Dent*. 1998;26(4):311-317.
10. Posselt A, Kerschbaum T. Longevity of 2328 chairside CEREC inlays and onlays [in German]. *Int J Comput Dent*. 2003;6(3):231-248.
11. El-Mowafy O, Brochu JF. Longevity and clinical performance of IPS-Empress ceramic restorations—a literature review. *J Can Dent Assoc*. 2002;68(4):233-237.
12. Keshvad A, Hooshmand T, Asefzadeh F, et al. Marginal gap, internal fit, and fracture load of leucite-reinforced ceramic inlays fabricated by CEREC inLab and hot-pressed techniques. *J Prosthodont*. 2011;20(7):535-540.
13. Almeida E Silva JS, Erdelt K, Edelhoff D, et al. Marginal and internal fit of four-unit zirconia fixed dental prostheses based on digital and conventional impression techniques. *Clin Oral Investig*. 2013. [Epub ahead of print May 29, 2013]
14. Henkel GL. A comparison of fixed prostheses generated from conventional vs digitally scanned dental impressions. *Compend Contin Educ Dent*. 2007;28(8):422-431.
15. Gehrt M, Wolfart W, Rafai N, et al. Clinical results of lithium-disilicate crowns after up to 9 years of service. *Clin Oral Investig*. 2013;17(1):275-284.
16. Kern M, Sasse M, Wolfart S. Ten-year outcome of three-unit fixed dental prostheses made from monolithic lithium disilicate ceramic. *J Am Dent Assoc*. 2012;143(3):234-240.