Moving Up With Digital Impression Technology

Several years ago, I became convinced that digital technology was ultimately going to take its position in restorative dentistry. As a practitioner and lecturer on the topics of preparations, impressions and provisionalals, I was interested in being an early adopter of this technology. Having had many years of experience placing zirconium oxide crowns, I was most interested in acquiring a digital impression technology that was designed to assist in this restorative process. The ability to use purely digital data to fabricate both traditional and computer-aided diagnostic/computer-aided manufacturing restorations, thereby avoiding possible distortion often associated with conventional impression material and gypsum die stone, was very intriguing.

Since the zirconium oxide crowns that I had been placing were Lava (3M ESPE), it was a logical step to research the Lava C.O.S (C.O.S is an acronym for Chairman Oral Scanner) system by 3M ESPE. This digital impression system was introduced in a phased rollout in 2008. In January 2009, I made the decision to purchase a system and to put it into regular use. Since then, we have completed more than 100 cases using this digital impression system and have witnessed the excellent results that can be achieved with it. This technology represents a fundamental change in how we take impressions for indirect restorations. Although there is a learning curve in learning how to use this technology, the increased accuracy and productivity, made possible with digital scanning, have made it a worthy investment. The following case report demonstrates how digital impression technology is used in our practice.

**CASE REPORT**

**Examination, Diagnosis, and Treatment Planning**

Ginny, a 69-year-old female, presented to the office in early 2008. Her chief complaint involved three teeth that fractured in the past year, and she was tired of the overall appearance of her teeth (Figures 1a and 1b). She stated that she wants to keep her teeth "...until I die."

Ginny's medical history included the diagnosis and treatment of breast cancer 20 years earlier. She had no contraindications to dental care.

Clinical examination revealed significant mandibular tori, mandibular, and maxillary buccal bony exostoses, teeth Nos. 12, 20, and 29 fractured off at the gingival line, and several crowns with cracked porcelain on the occlusal/axial surfaces. In addition, the existing crowns on teeth Nos. 2, 14, 19, and 31 had poor marginal integrity. Teeth Nos. 3, 10, 15, 16, 17, 18, and 32 were missing. In addition, tooth No. 2 had drifted into the place of tooth No. 3, and previous endodontic treatment had been performed on tooth No. 7. Tooth No. 10 was missing, replaced by an implant and ceramometal crown. Periodontally, there was minor bone loss interproximally in the upper and lower left quadrants. Only bite-wing and panoramic radiographs could be taken at the clinical examination appointment due to the very large mandibular tori.

Ginny knew that she needed extensive restorative care, and our clinical examination confirmed this need. Diagnostic information obtained included photographs, upper and lower diagnostic casts, a jaw relation record in centric occlusion, and a face-bow transfer. She was also referred to the periodontist for a consultation.

After considerable deliberation and discussion, we arrived at the following treatment plan:

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Figures 1a and 1b. The patient stated that she was tired of the unaesthetic appearance of her teeth.

Figure 2. The provisionalals were removed from teeth Nos. 22 to 27.

Figure 3. The prepared teeth, after placement of retraction cord and application of scanning powder.

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- Full-mouth periodontal surgery to remove the mandibular tori and the buccal bone exostoses.
- Removal of the hopeless teeth, with replacement using dental implants.
- Full-mouth radiographic series, to be taken after access was gained.
- After healing, the following information would be taken again: upper and lower impressions/diagnostic casts, face-bow transfer using a Kois dentofacial analyzer, and jaw relations in centric relation using a leaf gauge to open her vertical dimension of occlusion (VDO) approximately 1.0 mm in the anterior.
- Full-mouth diagnostic wax-up at the proposed/increased VDO.
  - Preparation and provisionalization of the maxilla and mandible utilizing a template fabricated from the approved diagnostic wax-up.
  - Completion of the case, after verification and acceptance of the new occlusion.

Clinical Treatment
We completed the posterior restorations first utilizing vinylpolysiloxane elastomeric impression material (Affinity Multi-Prep [CLINICANS CHOICE]), as unexposed implant margins were involved in these restorations. (Lava C.O.S is currently only indicated for fully exposed seated implant abutments). The restoration of the mandibular anterior segment, completed next, will be shown in this article. The maxillary anterior teeth will be the final step in the restorative phase.

For illustrative purposes, the accompanying photographs show the process of taking digital impressions and then restoring the anterior mandibular teeth, Nos. 22 to 27 using zirconium oxide (Lava) crowns. I selected these for the anterior crowns due to the material’s aesthetic and strength properties, as well as my prior positive experiences with the quality and accuracy of fit.

Before scanning teeth Nos. 22 to 27, the provisional (Integrity [DENTSPLY Caulk]) were removed (Figure 3). All preparations were cleaned with a plain flour of pumice and water paste. An initial retraction cord was placed circumferentially around all teeth (Ultra-pak cord soaked in Astringedent [Ultradent Products]), and the preparations were refined. A second retraction cord was then placed for final isolation of the prepared teeth. Next, the prepared teeth, and all other teeth to be scanned, were isolated (OpttraGate [3M Espe)]. After removal of the top cord all teeth were powdered lightly with the titanium dioxide provided (Figure 3), and then the Lava C.O.S wand was used to capture a digital impression of both arches.

While scanning, the 3-dimensional (3-D) image is displayed on the chairside monitor. (This ability to immediately visualize an image is a significant difference in taking digital impressions versus conventional impressions.) After the scan is complete, the system enables the operator to review the images and to confirm that all necessary data had been captured. If data gaps exist, another scan can be obtained, and the 2 scans are then seamlessly merged. After completion, an online prescription is completed on the Lava C.O.S monitor, and then sent electronically to the dental laboratory.

Laboratory Processing of the Digital Impression
Once a Lava C.O.S case reaches the lab, several steps in the production of the restoration are quite different from the traditional workflow (Sidebar 1, Technological Implications by Dr. Lou Shuman). The laboratory uses software to digitally mark the margins and cut the dies for the restoration (Figure 4). Then, this data is sent on to a 3M ESPE model production facility (Figure 5). There, a stereolithography apparatus (SLA) is used to create the model, as the model is scanned into a 3-dimensional (3-D) model of the restoration. Then, the model is sent back to the dentist for final polish and box out.

Technological Implications

Lou Shuman, DMD
For most patients, taking an Impression is often messy, claustrophobic, and can quite literally leave a bad taste in their mouth. New digital scanning technologies reduce or eliminate these inconveniences, potentially decrease chair time, and most critically, produce exceedingly accurate digital impressions. With little more effort than the wave of a wand, dentists are able to produce "impressions" that significantly improve the marginal integrity of the crown, occlusion, and contacts. These important technological advances will enhance our ability to accurately create intraoral restorations, while also improving the overall patient experience.

The following is a protocol synopsis for the technology (LAVA C.O.S [3M ESPE]) presented in this article.
(Note: Procedures for other available digital impression technologies can vary, ie, use of powder or not, etc.)
- Prepare: First, the tooth, associated arch, and opposing arch are coated with a titanium dioxide powder by the dentist.
- Scan: Instead of using a physical impression material, the dentist (or assistant, depending on State mandates) scans the prepared tooth, arch, opposing arch, using an easy-to-use wand (1/4 oz with a tip that is 13.2 mm wide). The wand captures pictures at video rate on 3 sensors and transfers data to a computer screen so that the dentist is able to view a video representation on a touch screen monitor in real time. The teeth in occlusion are also scanned. With the ability to scan the teeth in occlusion rather than having to place bite registration material between the teeth, this digital approach can achieve a superior bite registration.
- Review: Dentists can view the resulting images via video, 2-dimensional enhancement, or 3-dimensional stereography, making it possible to analyze the tooth from angles and perspectives that are typically inaccessible intraorally. For example, the scanned tooth can be viewed as though the dentist is standing directly behind the patient’s head, looking posterior to anterior. A digital impression also makes it possible to “tip” the prepared tooth in order to view any possible undercuts.
- Adjustments: While viewing the digital impressions and preparations, dentists can make any necessary adjustments, while the patient is still in the chair.
- Upload, Transmission, and Completion: Once the scanned impression is complete (about 5 minutes), the file is uploaded to 3M ESPE, where the data is stored and then sent to a margin marking lab. The file then goes to a model manufacturing lab where an articulated stereolithography apparatus model, comprised of photosensitive polymer resin, is manufactured. Finally, the model is sent back to the dentist’s own crown and bridge laboratory for fabrication of the restoration. (A fee of about $20 is charged to the restoration lab for model fabrication.) The time to complete the above process (from scan to arrival at the doctor’s laboratory for the final restoration work) is typically 3 days—about the same time it takes to send physical impressions from the doctor’s office to the lab.
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opposed to the laboratory's typical process of creating a stone model from an elastomeric impression. The SLA models created from the digital data are highly accurate, contributing to the final accuracy of the restoration (Figure 6). At the same time that the SLA model is being created, the digital information is also used to design and mill the Lava zirconia core which will be the substructure for the final crown. The model is only necessary for the final steps of the laboratory’s finishing processes related to articulation and interproximal contact creation (Figures 7a and 7b).

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Delivery Appointment

The zirconium oxide (Lava) crowns were completed by the dental ceramist and sent back to my office. In preparation for final placement, the 6 crowns were tried in after thorough cleansing of the prepared teeth. Minor adjustments were made to the interproximal contact areas of teeth Nos. 24 and 25 only. No other adjustments were necessary. The crowns were then permanently seated with a resin-reinforced glass ionomer cement (RelinX Luting Plus [3M ESPE]) (Figures 8a and 8b).

Ginny was very pleased with the appearance of her crowns. As her clinician, I was pleased with the accuracy of the fit created with the digital impression technology. The total time to complete all of these restorations was approximately 30 minutes, with virtually no adjustment.

DISCUSSION

Digital impression technology represents a fundamental change in the way that dentists practice, and therefore requires discipline and consideration to properly implement (Sidebar 2, Practice Management Considerations in Implementing Digital Impression Technology by Amy Morgan). As previously mentioned, when using a traditional impression technique, the dentist focuses totally intraorally. Digital scanning moves this process into an electronic domain. Therefore, it is an adjustment to learn to focus on the chairside monitor while positioning the wand in the patient’s mouth. In my experience, this takes practice to master, and the process can initially be a bit frustrating. However, once I learned to operate the device smoothly, it became a wonderful tool to help make better quality restorations.

Since the image is captured in 3-D video and modeled back in real time on the chairside monitor, this allows the user to assess the quality of the scan right away. There is no more wondering whether a distortion in the impression material will compromise the fit of the final restoration.

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Produced with this process makes an appreciable difference versus conventional impressions, greatly reducing seating times.

An added benefit to the device's functionality is that it can be used not only to create Lava restorations, but other types as well. I have used it successfully for cast gold crowns and lithium disilicate pressed ceramics. The accuracy of digital scanning can be applied to many different restoration types. I am now convinced that the scanner will capture what it can see with unparalleled accuracy.

Before I purchased a Lava C.O.S. unit for my office, I had the opportunity to handle it briefly during a demonstration at the ADA meeting in San Antonio. I immediately began developing some ideas about how I would incorporate the technology into my practice. The process of using the device is different for every dentist, and it is a continual evolution that changes based on the experiences each user has in the office. I believe that the learning curve is directly related to the number of cases that you complete. Every case is an opportunity to improve your skills and results. The user gets an exciting sense of participating in a major change in the profession. The patients get a far better clinical result.

CLOSING COMMENTS

Although digital impression technology can help dentists capture better data for better-fitting restorations, it cannot make up for inadequate preparation and tissue management. The only errors in the system are those that we humans create. I also like to emphasize that it's a scanning wand, not a magic wand, and it takes some time to adjust to the fundamental differences between taking conventional and digital impressions.

Prior to acquiring digital impression technology, I was not having any