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INTRAORAL SCANNING

*Improving Efficiency
and Advanced
Workflow*

By Alessandro Agnini, DMD and Andrea Mastroso Agnini, DDS



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ABSTRACT

Digital impressions are reshaping the way modern dentistry is being practiced. They are able to eliminate some of the issues found with conventional workflow and provide clinicians with unique advantages compared to traditional impression techniques. With various implications in the field, digital scanners are making their mark on the profession. This article will review some of the advantages of digital impression systems over their conventional counterparts, as well as review how they are currently being used in practice today.

EDUCATIONAL OBJECTIVES

After completing this course, participants will be able to identify potential advantages of digital impression systems over conventional impressions, as well as be able to:

1. Comprehend how digital impressions are being used to fabricate dental restorations
2. Understand how digital impressions are impacting orthodontics
3. Learn how digital impressions are being used in implantology
4. Recognize the potential benefits of CAD/CAM technologies
5. See the potential in diagnostics and communication with patients.

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Introduction

Efficient workflow is paramount to the success of a practice. It is important for each staff member, both clinical and administrative, to understand their role in treatment and to execute their tasks efficiently for this to occur. Continuous technological advancements in the field of dentistry are causing a shift away from traditional dental workflow, none more than the advent of the intraoral scanner and digital impressions. Traditionally, dental workflows involved taking conventional impressions, that were often times found to be uncomfortable by patients, with costly materials. In addition to the discomfort and cost associated with using these materials, time wasted in the process of sending the impressions to and from the laboratories created a significant set back. Digital impression systems have helped to eliminate these issues, while also improving clinical efficiency.

Despite having a successful track record, conventional impression workflows have notable drawbacks that may result in compromised restoration quality, sometimes costing practitioners valuable chair time and money on lab fees. For example, there are several intermediary steps between initially taking the impression to the placement of the final restoration where errors in the workflow can result in an unacceptable final product. Some of these errors include improper soft tissue management, which can lead to the inability to capture margins adequately, incorrect tray selection, issues during separation of impression material from the tray, and distortion of the impression before pouring. Another potential downside of conventional impression material is the fact that they often need to be mixed by manual or mechanical means. Improper mixing (either by clinic team member or machine) can lead to ill-fitting restorations and/or appliances and require retaking of the impression, costing the clinician chair time and material cost, while also



Figure 1. Traditional analog impression technique

inconveniencing the patient.

By virtue of using an intraoral scanner to capture a digital image, issues with tray selection, separation of impression material, and distortion before pouring have become obsolete. Soft tissue management, particularly when taking an impression for an indirect restoration, however, must still be taken into account when taking digital impressions. Despite the fact that some scanners require powders that can make impressions messy, most modern day scanners do not. As a result, they are less messy and do not require the cleanup necessitated with conventional impression materials.

This is not to say digital impressions never need to be redone; however, this is not at the cost of extra wasted materials. Some digital impression software can provide the clinician with real time feedback or if the prep is under-reduced, margins are not adequate, and so on. This allows the practitioner to re-scan the area to obtain all the necessary information for a particular restoration. Often, this can be done without starting over with a completely new scan, but rather adding the new information to the existing one.

The use of digital scanners has other advantages over



conventional impressions. One such advantage is in the replication of models, particularly after the patient has left the operatory. For instance, in the event a model is poured incorrectly or accidentally broken or misplaced, the model needs to be remade. In the conventional impression workflow, the new model is made in one of two ways: reuse the same impression or take a new one, both of which have their own downfalls. For instance, in order to reuse an old impression, it is presumed that the original impression was not discarded or distorted. This assumes the practitioner took the care to maintain the integrity of the impression and has kept it. With digital scanners, these concerns are nonfactors as the impressions are safely stored and maintained, undistorted, as digital files and ready to be reprinted.

One concern with the digitization of impressions was the accuracy of the impressions taken compared to traditional options. There are several studies that compare digital impressions to conventional impression materials such as alginate and polyether. One such study compared the marginal fit of pressed all-ceramic crowns made on dies fabricated from digital impression systems with those from conventional vinyl polysiloxane (VPS). In this study, a full coverage, all ceramic crown preparation was completed on a partial maxillary posterior typodont. Ten conventional VPS impressions were taken using a double mix technique of light and heavy body material, while ten scans using the iTero (Cadent) impression system were acquired. Dies obtained from both types of impressions were used to fabricate pressed all ceramic crowns. Marginal fit was evaluated using the “replica technique” in which each crown was fitted with a light body VPS and seated onto the preparation with 1 kg of pressure.² At this point the crown was removed and the resulting material was embedded in heavy body VPS material. The replica was then sliced, photographed, and analyzed under a stereomicroscope. This comparison

found no statistically significant differences between the two types of impressions and the authors concluded that all-ceramic crowns obtained from both impression types were comparable.²

With purported advantages over conventional impressions, and comparable accuracy, many practitioners are opting to take impressions using digital systems. One of these advantages is decreased time needed in the fabrication of a restoration. This advantage stood out clearly in a study conducted by Schulze et al. comparing the time needed for adjustments of single unit posterior crowns fabricated by digital impressions compared with others created using conventional impression technique.³ In this study, 100 crowns were investigated, 50 fabricated using digital impressions with an iTero 3-D scanner and plastic models, while the other 50 were made utilizing Aquasil impression material and stone models. Before cementation, certain parameters such as margins, intaglio surfaces, and proximal contacts were evaluated and the amount of time needed for all adjustments was observed. This study found that a time savings of 22% was attained on crown adjustments prior to cementation when using the digital impression system versus conventional impression technique.³

Digital impressions are commonly used in various aspects of dentistry and will likely be used more commonly as the technology advances. Tied hand and hand with digital impressions are computer-aided design and computer-aided manufacturing (CAD/CAM) systems. These systems use digital impressions, or scans of models made using conventional impression techniques, to automatically fabricate restorations either in the lab or in-house. Although the focus will remain on the impression aspect of digital workflow, we will touch on CAD/CAM technologies toward the end of this article. For now, we will focus on the applications of digital impressions and how it can positively impact workflow.



Orthodontic Applications

Digital impressions can be used to fabricate everything from aligners and retainers to functional appliances and space maintainers. Because they are captured digitally, impressions can be sent to laboratories instantly, drastically reducing turnaround time. The same process is used when sending impressions to Align. For example, according to a review by Jones, when using an iTero scanner to capture a digital impression for aligners, impressions can be posted in the Invisalign Doctor Site for review in 2–3 days and aligner delivery can be reduced by nearly half.⁴ Once uploaded to the Doctor Site, clinicians have the ability to customize treatment goals and how they are achieved. For example, on the online prescription form, practitioners can dictate preferred methods of addressing crowding (i.e., expansion vs proclination) and anteroposterior discrepancies [posterior interproximal reduction (IPR) vs sequential distalization]. When presented with deep bite or open bite cases, clinicians can choose between intrusion/extrusion of anterior/posterior teeth or any desired combination of the two. They also have the ability to make anchorage decisions to achieve the desired space closure in extraction cases. These options allow for customizable treatment on a case-to-case basis and allow the practitioner to carry out mechanics similar to that achieved with conventional fixed appliances. It is important to note that conventional impressions, as well as digital impressions captured by other systems such as the 3 Shape Trios scanner or CEREC Omnicam, can also be used for clear aligner fabrication. Each digital impression system comes with its own unique set of features that may be more suitable for any given practitioner's clinic needs. There are also other aligner systems, such as Clear Correct, on the market that can be used for orthodontic treatment.

As in other disciplines of dentistry, impression accuracy is of utmost importance in orthodontics. A report by Garino, Garino, and Castroflorio details some clinical

examples where digital impressions can provide more accurate information than is possible with conventional VPS. To obtain these results, the authors conducted a study that took place over two years and included a total of 328 scans used for orthodontic treatment (Invisalign ClinCheck, virtual set ups, and digital study models). All of the scans were completed with an iTero scanner by one of two operators and subjected to two quality control checks (first visually on-screen and then by the scanning software) before submission.

Some of the aforementioned clinical examples include upper second molars in Class II treatment, severe crowding, ectopic incisors/canines, and severe deep bite.⁵ The authors go on to mention, particularly in regard to ectopic incisors/canines, that the Invisalign software places red circles around missing data and therefore can alert the operator that additional scanning must be completed.⁵ The authors also include extractions/missing teeth and late mixed dentition as other clinical scenarios that may be better captured with digital scanners. The authors make note of a feature in Invisalign Teen called “eruption compensation,” which allows a clinician to submit the widths of unerupted teeth to be accommodated in the

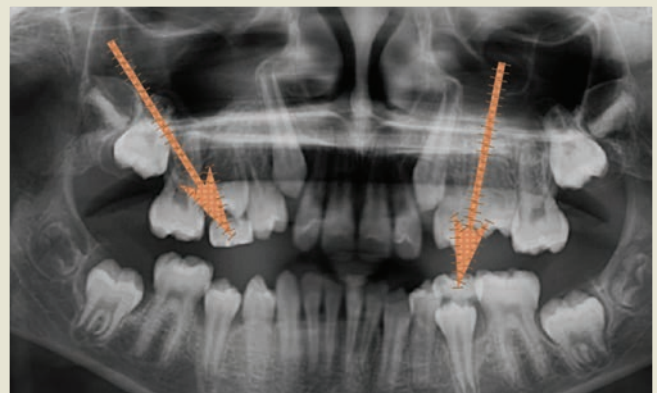


Figure 2. Panoramic radiograph showing delayed eruption of primary molars

Image courtesy of Dr. Michael Florman.

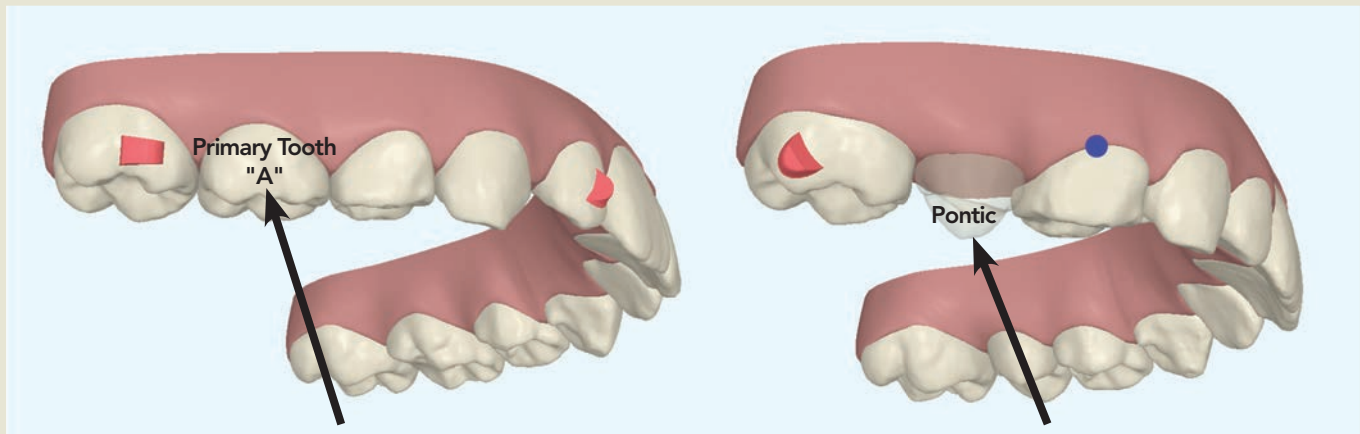


Figure 3. A pontic will be added to aligners to allow for the eruption of tooth #4. The pontic will be placed on all subsequent aligners until tooth #4 erupts, at which time a new scan will be taken, and new aligners fabricated.

Image courtesy of Dr. Michael Florman.

aligners and to be directed during eruption.⁵ Features like these afford clinicians with advantages not provided with traditional impression materials.

It is no secret that models are important to orthodontic treatment planning. In fact, some studies have found that they are the most important record for it.⁶ A study by Ko et al. investigated the differences in orthodontists' treatment plans when evaluating digital models in contrast with plaster models. In this study, 20 initial records of patients who were already treated were obtained from the University of Washington's orthodontic patient population. These records were then divided into two groups of 10 with comparable distribution of malocclusions, including varying severity of crowding and dimensional issues (i.e., anteroposterior, transverse, vertical). The previously obtained models were scanned using the iTero HD 2.9 intraoral scanner to create digital models. Orthodontists were then asked to evaluate a total of 20 patients at the beginning of the study (T1) and then again at the minimum three months later (T2). The assignment of cases was done to guarantee equal distribution of assessment combinations

of digital and plaster models. All of the treatment plans were recorded and used to compare differences between the two model types.

This study found that the use of digital and plaster models resulted in similar treatment plans with various malocclusions, similar intra-rater agreement rates at the two times presented, and similar time spent viewing the models.³ Based on these findings, the authors claim that "digital models can be substituted for plaster models with no significant differences in the final plan."⁶

Not only do we have the ability to capture impressions digitally, but now we are able to analyze digital models in the same manner. Analysis of treatment results is important to clinicians and can help hone a practitioner's treatment protocols. The American Board of Orthodontics (ABO) uses a system called the cast-radiograph evaluation (CRE) to analyze treatment outcomes. This system involves eight criteria in its evaluation including categories such as alignment and rotations, occlusal contacts, marginal ridges, and overjet.⁷ These evaluations have traditionally been completed by hand with gauges on plaster models;



however, new technological developments have provided us with digital options.

In a study by Scott et al., plaster models from 15 cases, that were previously submitted to the ABO and received a passing score for cast-radiographic evaluation, were scanned with a 3Shape R700 desktop scanner to create digital and new physical models with a 3D printer. The 3D printed models of all 15 cases were graded by eight CRE-calibrated graders, while the digital impressions were submitted to SureSmile for automated grading. This study found that SureSmile assessed statistically significantly higher scores to alignment and rotations, occlusal contacts, overjet, and total score; however, no significant differences were found in interproximal contacts, marginal ridges, and occlusal relationships.⁴ Due to these results, the authors concluded that digital scores by SureSmile are comparable to those acquired through hand grading and note that such technologies can help “streamline the research process” and eliminate hours of work spent on hand grading.⁷

Digital impression systems are changing the game in orthodontics. With its use in the fabrication of various appliances, it is no surprise that digital scanners are popping up in more orthodontic practices. Similar results to their conventional counterparts, improved workflow, and faster turnaround times are just some of the benefits of using this technology. When combined with Invisalign software, orthodontists are able to customize treatment more now than ever before. Digital impressions/models are also substituting plaster models when making treatment plan decisions and in the evaluation of treatment results. We will now turn our attention to the use of digital impressions in restoration fabrication.

Digital Impressions and Restorations

Digital impressions can be used to fabricate many different dental restorations including inlays, onlays, single

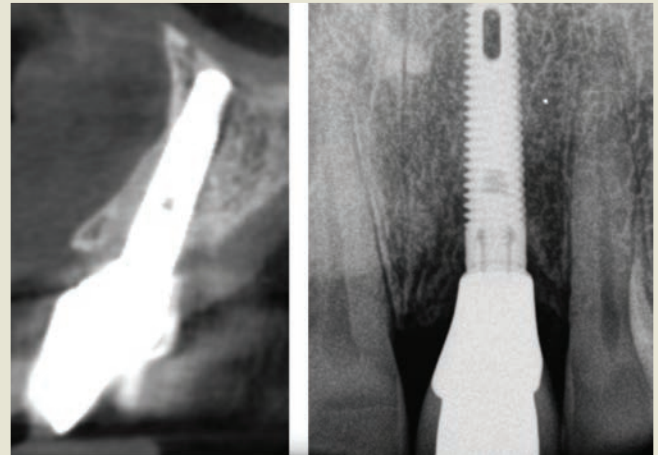


Figure 4. Implant radiographs

crowns, and bridges, both on implants and natural dentition. These impressions can be captured in one of two ways: extraorally by scanning models obtained from conventional impression techniques or intraorally by directly scanning a patient’s dentition. Extraoral scanning of models for CAD/CAM systems began in the 1980s and was the preferred option at the time because intraoral scanners were time-consuming and not as accurate.⁸ Over the years however, intraoral digital impression systems have improved and are regularly used in the fabrication of dental restorations. Intraoral digital impressions can provide certain advantages over conventional impressions such as faster turnaround times on restorations and even reduction of impression time. Some studies even show that practitioners may prefer digital impressions over their conventional counterparts. In a study comparing dental students’ perception of impression techniques, 14 dental students at the University of Texas Health Science Center San Antonio performed both conventional impressions (VPS) and digital impressions (CEREC Bluecam) on a typodont with a crown preparation on either tooth #19 or #30.⁹ Efficiency of both impression types were examined by measuring the amount of working time, retake/scan time, and the number of retakes/rescans. A



Figure 5. Fully healed implant site prior to restoration placement



Figure 6. Successfully restored implant

visual analog scale questionnaire was then used to determine the participants' perception on difficulty for both impression types. This study not only found digital impressions to be faster, but found them to be preferred by the dental students as well (57% of them favored the digital technique, while only 29% preferred the conventional option).⁹

In a review of digital impression systems with intraoral scanners for fabricating restorations and fixed dental prostheses, Takeuchi et al. note several different studies that compared the impression times required by intraoral digital systems to conventional impressions. They found that a number of these studies showed the total time needed for digital impressions was shorter than their conventional counterparts.⁸ Despite notable improvements over the years, however, the same review does make mention of several studies that reported intraoral scanning was still less accurate than extraoral digitization of stone models.

The reasons for these discrepancies were inherent to working in the oral cavity and included factors such as saliva contamination, limited spacing, and scanning position.⁸ Despite these findings, the authors go on to note that marginal gaps for restorations and fixed dental prostheses made with intraoral scanners were less than 120 μm , which is as clinically acceptable as those acquired by indirect scanning.⁸ They also mention two studies that found that ceramic restorations made with intraoral scans

had equal or superior interproximal contacts and occlusal point quality when compared to ceramic restorations fabricated from conventional impressions.⁸

Digital impressions are also more accepted by patients for the fabrication of restorations. In a study by Yuzbasioglu et al., digital and conventional impression techniques were compared on patient preference and comfort. In this study, 24 patients (12 men, 12 women) with no previous impression experience were selected. The patients were then presented with a clinical scenario of "excessive destruction of a mandibular molar and crown fracture of the lateral incisor, which would be restored by post-core and all-ceramic crowns."¹⁰ For the conventional impressions, polyether material was used to capture the maxillary and mandibular arches, while polysiloxane was used to take the bite registration. The digital impression was taken using the chairside dental CAD/CAM system two to three weeks later. Total treatment time for each impression was recorded (this included the time spent on all steps including tray selection, adhesive application, time spent writing the lab prescription, etc.) and patients were asked to complete a standardized questionnaire following each impression. The State-Trait Anxiety Scale was used after each impression to evaluate the subjects perceived stress source.

After completing both types of impressions, subjects were asked to complete a nine-item comparative



questionnaire including questions such as: “Which was the preferred impression technique? Which impression technique was more efficient?”¹⁰ The study found that the digital impression technique was more time-efficient than its conventional counterpart, with the overall treatment time for the digital impression technique statistically significantly less.¹⁰ They also found that the digital impression technique was preferred, as all the participants chose it over the conventional impressions.¹⁰

Despite these benefits, it is important to note that more research needs to be done on restorations fabricated using digital impressions. In a systematic review and meta-analysis, Nagarkar et al. aimed to investigate the survival rate of full coverage restorations fabricated using digital impressions versus those made with conventional impressions. Secondary outcomes such as occlusal and interproximal contacts, as well as marginal and internal fit, were also investigated. For this review, 10 studies met the final inclusion criteria, none of which compared the impression techniques in regard to survival of full coverage restorations.¹¹ In regard to marginal and internal fit, the studies did suggest similar results from both impression techniques; however, the quality of the evidence was low.¹¹ The quality of evidence was very low when evaluating interproximal and occlusal contacts, such that it was inadequate to draw any conclusions regarding how the two impression methods compared.¹¹ This review highlights the lack of substantial evidence regarding full coverage restorations fabricated using digital impressions and brings to light the need for more high quality studies, particularly as these impression systems grow in popularity.

Despite the need for more, higher quality studies on restorations made using digital impressions, these systems are being successfully used to fabricate various types of dental restorations. With advantages such as faster turnaround times, less time spent capturing an impression,

and increased patient acceptance, digital impression systems are gaining popularity in restorative dentistry. We will now turn our focus to the use of these systems in implantology.

Digital Impressions in Implantology

Digital impression systems have also found their place in the world of implant dentistry. As with the fabrication of restorations, traditional implant workflow involved the use of conventional impression materials and mailing said impressions to the laboratory for fabrication of custom abutments or implant crowns. Now, with the use of digital impression systems, clinicians are able to opt for a faster, digital workflow.

Impressions, digital or conventional, are of utmost importance in implantology. For instance, ill-fitting bridges on natural dentition will result in unwanted forces on the underlying teeth. Natural teeth, however, are able to adapt slightly to ill-fitting restorations due to the periodontal ligament. In fact, teeth can move 25–100 μm in the axial direction, while being able to move 56–108 μm to the lateral.¹² Implants, on the other hand, are unable to adapt to ill-fitting frameworks to the same extent. They can only move 3–5 μm in the axial and 10–50 μm in the lateral direction after osseointegration.¹² Ill-fitting frameworks can generate forces that can cause a biological effect on the interface between bone and implant.¹² Thus, well-fitting frameworks are an absolute must. For this to occur, the impression needs to be accurate.

In a study by Lee et al., the accuracy of digitally milled models created from direct digitization of a reference model was compared to gypsum models from a conventional implant impression. Thirty gypsum and 30 of the digitally milled models were prepared and scanned, along with the reference model, by a laboratory scanner and imported to an inspection software program. This study found that the milled models from the digital impressions had similar accuracy to the gypsum models



obtained from the conventional impression technique.¹³

Digital impressions for implants may also have the added benefit of better time efficiency and ease of use when compared to conventional impressions. In a pilot study by Lee and Gallucci, the authors investigated the efficiency, difficulty, and clinician's preference of a digital impression compared to a conventional impression for a single implant. In this study, 30 Harvard University School of Dental Medicine students, who had no previous experience to either conventional or digital implant impressions prior to the study, performed digital and conventional implant impressions on a customized model presenting a single implant. The impressions were evaluated under an acceptance protocol and a decision was made on whether the impression needed to be retaken. The efficiency of both impression methods was evaluated by measuring the total treatment time and the number of retakes or rescans needed to acquire an acceptable result. A Visual Analog Scale (VAS) questionnaire was utilized to assess the participants' perception on the level of difficulty. Operator perception on "preference, effectiveness, and proficiency" was evaluated via a multiple-choice questionnaire.¹⁴ This study found that digital impressions took a statistically significantly less amount of total treatment time and was thus more efficient.¹⁴ They also found that conventional impressions necessitated a longer preparation time, working time, and retake time when compared to the digital impressions. The study also found that the digital impressions were rated as having a lower level of difficulty and was the more preferred and effective method according to the participants' perceptions.¹⁴

With digital systems able to capture implant impressions with similar accuracy to conventional ones, while presenting/providing clinicians with a faster and easier-to-use option, it was only a matter of time before these systems were being used in implant cases. The final section of this piece will touch on CAD/CAM systems and how they can be used to promote a more efficient workflow.

CAD/CAM Systems

Although first introduced in the field of dentistry in 1971 by François Duret, the first commercially available dental CAD/CAM system was the CEREC system in 1985.^{15,16} Over the years, the technology has evolved immensely, and can provide clinicians with many unique advantages. CAD/CAM systems give practitioners versatility in design and provides automation in the manufacture of restorations. This automation has the advantage of quality control and reduced labor costs.¹⁷ These systems also have the potential benefit of minimizing mistakes in technique and improving infection control by reducing some cross-contamination risks by virtue of eliminating certain steps in the conventional workflow.¹⁸

As the technology has evolved, CAD/CAM systems are able to utilize various materials in their fabrication of restorations and provide efficient results. For example, systems are able to use presintered alumina and zirconia blocks combined with veneer ceramics for posterior crowns and fixed partial dentures.¹⁸ CAD/CAM systems can also be used with restorations requiring metal and can be used to fabricate crowns, fixed partial dentures, inlays, onlays, and veneers.

The aforementioned advantages are not limited to the realm of general dental restorations. CAD/CAM systems now have a role in implantology as these systems have been utilized in the fabrication of implant abutments and diagnostic templates.¹⁵ With CAD/CAM systems, clinicians can provide abutments that are specifically tailored to an individual patient, often at a lower price than a laboratory-made custom abutment.¹⁵ In an update on CAD/CAM systems in implant dentistry by Fuster-Torres et al., the authors state that CAD/CAM systems have the potential to provide a more accurate fit than both their stock and lab-fabricated counterparts because the intrinsic errors sometimes caused during "waxing,

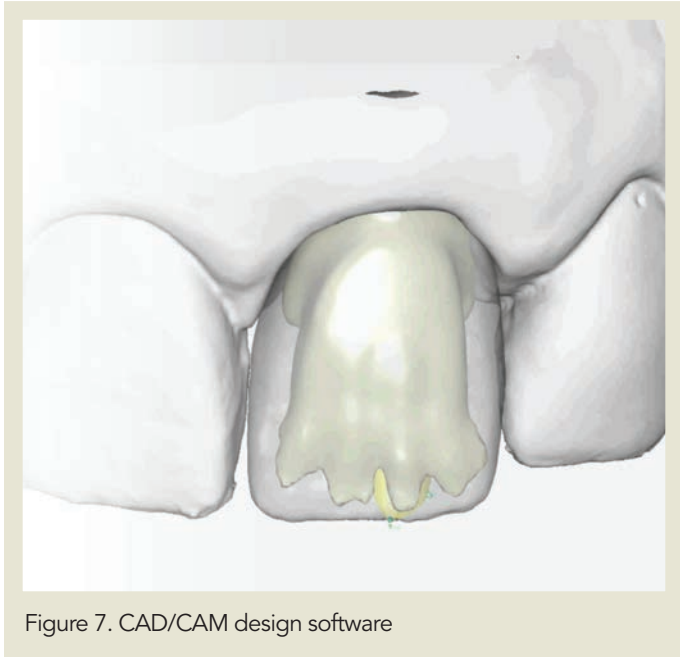


Figure 7. CAD/CAM design software

investing, and casting are eliminated.”¹⁵

Some practitioners are using CAD/CAM systems and CBCT technology when treatment planning for implant cases. The practitioner is provided with more information through the software and technology, while also reducing the number of procedures and improving workflow when compared to the conventional implant procedures.¹⁵ This combination can aid the practitioner from initial treatment planning to implant placement to fabrication of abutments and/or final restorations, all while improving precision and predictability.¹⁹

Another way the combination of CBCT technology and CAD/CAM systems can positively impact treatment, as well as workflow, is with the fabrication of surgical guides. Traditionally, implant guides were fabricated using 2D radiographs and models; however, implant planning was limited by these 2D images as they provided incomplete information regarding 3D anatomic structures such as exact nerve position, bone height, and buccolingual measurements.²⁰ Now, however,

practitioners have the option to use 3D radiograph systems and their software in the planning of implant placement. Using this, the clinician is afforded many advantages such as the ability to analyze potential implant sites in three dimensions as well as planning the number, size, and type of implant to be placed.²¹ Once the 3D image is captured, a surgical guide can be fabricated using software, and can then be printed using stereolithography or selective laser sintering.²¹ If the clinician has an in-office CAD-CAM system, the surgical guide can be printed in office, further improving workflow by elimination of the laboratory step. Surgical guides can be supported by either teeth, bone, or mucosa, with studies showing superiority of tooth borne guides.²²

CAD/CAM systems, particularly in-office systems, have the ability to expedite treatment. By utilizing digital scans, they are able to fabricate a plethora of dental restorations and can give clinicians various options when choosing a restorative material. These systems can also be used to fabricate custom implant abutments and surgical guides, as well as to help reduce errors created during conventional workflow.

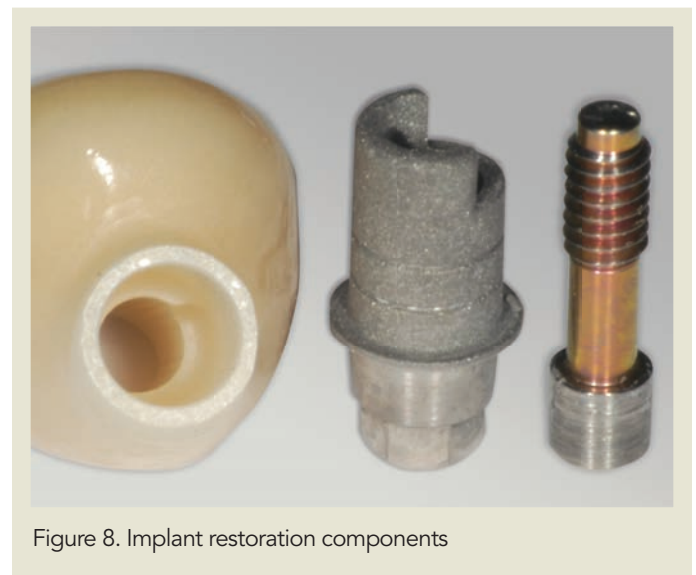


Figure 8. Implant restoration components



Conclusion

Digital impression systems are on the forefront of dental innovation that is reshaping the way modern dentistry is practiced. These impressions can be utilized in all aspects of dentistry from dental restorations to orthodontics to implantology. They have been found to provide comparable results to their conventional counterparts, while affording clinicians with advantages not possible in conventional workflow. It seems that the pros of going digital outweigh the cons as more and more clinicians are opting to utilize these systems. As the technology advances, these systems will likely be utilized more, with even more applications in the field.

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CEQuiz

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1. Some errors that can occur during conventional impression workflow that can lead to poor fitting restorations include which of the following?
 - a. Incorrect tray selection
 - b. Improper separation of impression material
 - c. Distortion of the impression before pouring
 - d. all of the above
2. Improper mixing of conventional impression materials can lead to inaccurate models and thus ill-fitting restorations.
 - a. True
 - b. False
3. Digital impression software is capable of informing clinicians of incomplete data, prompting them to redo a scan.
 - a. True
 - b. False
4. Some of the advantages of using digital impressions over conventional ones include _____.
 - a. ease of model replication
 - b. digital storage
 - c. both a and b
 - d. none of the above
5. In a study that compared marginal fit of pressed ceramic crowns made on dies fabricated from digital impression systems with those from conventional vinyl polysiloxane (VPS), researchers found which of the following?
 - a. Statistically significant differences favoring the VPS technique
 - b. Statistically significant difference favoring the digital impression technique
 - c. No statistically significant differences between the two techniques
 - d. none of the above
6. In a study by Schulze et al. that compared the time needed for adjustments of single-unit posterior crowns fabricated by digital impressions vs those created using conventional techniques, researchers found a time savings of what percent (prior to cementation) when using the digital impression system?
 - a. 22%
 - b. 32%
 - c. 42%
 - d. 52%
7. A review by Jones found that when using the iTero scanner to capture digital impressions for aligners and sent to Invisalign, aligner delivery time can be reduced by nearly what amount?
 - a. One-quarter
 - b. One-third
 - c. One-half
 - d. none of the above
8. Using the Invisalign prescription form, clinicians are able to dictate preferred methods to address which of the following?
 - a. Crowding
 - b. Anteroposterior discrepancies
 - c. Deep bite cases
 - d. all of the above
9. According to a report by Garino, Garino, and Castroflorio, which of the following clinical situations may better be served by using digital impression systems to capture the impression?
 - a. Upper second molars in Class II cases
 - b. Severe crowding
 - c. Ectopic incisors/canines
 - d. all of the above
10. Invisalign Teen has a feature called "eruption compensation" which allows a clinician to submit the widths of unerupted teeth in order for them to be accommodated in the aligners and to be directed during eruption.
 - a. True
 - b. False
11. In a study by Ko et al. that compared the differences in orthodontists' treatment plans when evaluating digital models to plaster models, the investigators found which of the following?
 - a. More extraction-based treatment plans when using digital models
 - b. Less extraction-based treatment plans when using digital models
 - c. Similar treatment plans with various malocclusions
 - d. none of the above
12. The American Board of Orthodontics uses which system to analyze treatment outcomes?
 - a. Cast-radiograph evaluation
 - b. Chart-radiograph evaluation
 - c. Cast-reality evaluation
 - d. none of the above.
13. In a study by Scott et al. that compared hand graded scores of casts to digital scores completed using SureSmile, investigators found that the scores were NOT comparable.
 - a. True
 - b. False
14. In a study of dental students from the University of Texas Health Science Center San Antonio that compared the students' perception of impression techniques (digital vs conventional), researchers found:
 - a. digital impressions to be faster
 - b. conventional impressions to be faster
 - c. both impression techniques to take the same amount of time
 - d. none of the above
15. The same study compared the students' perception of impression techniques and found that these dental students preferred the _____.
 - a. conventional impression technique
 - b. digital impression technique
 - c. both equally
 - d. neither



CEQuiz

16. In a review of digital impression systems with intraoral scanners for fabricating restorations and fixed dental prostheses, Takeuchi et al. note several different studies that compared the impression times required by intraoral digital systems and conventional impressions and found which of the following?
- Total time needed for conventional impressions was shorter
 - Total time needed for digital impressions was shorter
 - Times were the same for both options
 - none of the above
17. The same review by Takeuchi et al. mentions several studies on the accuracy of intraoral scanners when compared to extraoral digitization of stone models. These studies stated which of the following?
- Intraoral scans were just as accurate
 - Intraoral scans were more accurate
 - Intraoral scans were less accurate
 - none of the above
18. Reasons for discrepancies between intraoral scans and extraoral digitization of stone models include which of the following?
- Saliva contamination
 - Limited spacing
 - Position of the scanner
 - all of the above
19. A study by Yuzbasioglu et al. evaluating differences in patient preference and comfort during digital impressions versus conventional impression techniques found which of the following?
- Digital impression technique was more time efficient
 - Conventional impression technique was more time efficient
 - both techniques were about the same in regard to time efficiency
 - none of the above
20. The same study by Yuzbasioglu et al. found which impression technique to be preferred by study participants?
- Conventional impression
 - Digital impression
 - both were preferred equally
 - none of the above
21. When comparing marginal and internal fit of full coverage restorations fabricated using digital impressions versus conventional impressions, a systematic review by Nagarkar et al. found what level of evidence indicating similarities between the two techniques?
- Low
 - Medium
 - High
22. The same study by Nagarkar et al. found what level of evidence when evaluating interproximal and occlusal contact?
- Very low
 - Medium
 - Very high
23. Natural teeth adapt better to ill-fitting restorations due to the periodontal ligament.
- True
 - False
24. Natural teeth can move how much in the axial direction?
- 25–100 μm
 - 100–125 μm
 - 125–200 μm
 - none of the above
25. Implants can move how much in the axial direction?
- 3–5 μm
 - 5–10 μm
 - 10–30 μm
 - none of the above
26. In a pilot study by Lee and Gallucci investigating the efficiency, difficulty, and clinician's preference of a digital impression compared to a conventional impression for a single implant, the investigators found which of the following?
- Conventional impressions took a statistically significantly less amount of total treatment time and was thus more efficient
 - Digital impressions took a statistically significantly less amount of total treatment time and was thus more efficient
 - both were equally efficient
 - none of the above
27. CAD/CAM was introduced into the field of dentistry in ____.
- 1970
 - 1971
 - 1972
 - 1973
28. The CEREC system became the first commercially available CAD/CAM system in ____.
- 1983
 - 1984
 - 1985
 - 1986
29. CAD/CAM systems can be used to fabricate which of the following?
- Crowns
 - Inlays
 - Onlays
 - all of the above
30. When compared to 2D radiographs, using CBCT technology to treatment plan implant cases can provide the practitioner with more information on anatomical structures such as:
- nerve position
 - bone height
 - buccolingual measurements
 - all of the above

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EDUCATIONAL OBJECTIVES

- Comprehend how digital impressions are being used to fabricate dental restorations
- Understand how digital impressions are impacting orthodontics
- Learn how digital impressions are being used in implantology
- Recognize the potential benefits of CAD/CAM technologies
- See the potential in diagnostics and communication with patients.

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|-------------------------|-------------------------|
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| 2. (A) (B) (C) (D) (E) | 17. (A) (B) (C) (D) (E) |
| 3. (A) (B) (C) (D) (E) | 18. (A) (B) (C) (D) (E) |
| 4. (A) (B) (C) (D) (E) | 19. (A) (B) (C) (D) (E) |
| 5. (A) (B) (C) (D) (E) | 20. (A) (B) (C) (D) (E) |
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| 10. (A) (B) (C) (D) (E) | 25. (A) (B) (C) (D) (E) |
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