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Indirect Restorations Then & Now:

A Comparison of Analog & Digital Workflows

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Daniel Butterman

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ABSTRACT

Modern-day dentists have the luxury of choosing among several methods for fabricating indirect restorations. Although the traditional workflow has been effective for decades, technological advancements are changing the norms and providing practitioners with a more efficient option. Digital impressions and chairside CAD/CAM systems allow providers to deliver high-quality restorations to patients faster and in fewer appointments. This course compares the traditional analog workflow with the digital approach, as well as highlights how digital impressions and CAD/CAM technology can help streamline restoration fabrication and improve clinical efficiency.

EDUCATIONAL OBJECTIVES

On completion of this program, the student should be able to:

1. Distinguish the similarities and differences comparing traditional, digital, and CAD/CAM impression techniques
2. List the differences among current impression materials
3. Describe how digital impressions and CAD/CAM technology can improve efficiency
4. Explain how digital and CAD/CAM technology relates to patient care and acceptance.

ABOUT THE AUTHOR

Dr. Daniel Butterman is a 1994 graduate of the University of Maryland School of Dentistry. He also is a graduate of the Misch International Implant Institute, a Fellow in the International Congress of Oral Implantologists, and a member of PEERS. Dr. Butterman is an advanced CEREC trainer and resident faculty member at CDOCS.com. He is a hardware and software beta tester for Dentsply Sirona's CAD/CAM and implant products, and maintains a general practice in Centennial, CO.

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The analog workflow, with its requisite physical impression materials, is the traditional method for fabricating indirect restorations. It has been around for decades and still is commonly used in many dental practices worldwide. Over the past few years, vast improvements to digital technology have revolutionized the traditional workflow, creating a streamlined and predictable process with faster and more accurate results. In this course, we will begin with a discussion of the analog workflow. After we analyze its limits and pitfalls, we will transition to the digital workflow, discussing CAD/CAM advantages and advances, as well as its impact on dentistry.

Analog Workflow

Let's begin with the analog workflow. After the patient is anesthetized and the tooth is prepared for the restoration, a manual impression is needed for the laboratory to fabricate the final restoration. The practitioner has to make a choice among the products available and decide which impression material works best for the clinical situation. Following is a discussion of the traditional impression materials available.

Traditional Impression Materials

Each dental impression material has a given set of innate characteristics that may make it more beneficial in a given clinical situation over another material. In this section we will focus on the most common materials—polyvinyl siloxanes and polyethers—used when fabricating indirect.

Material characteristics. When evaluating impression materials, certain characteristics (such as accuracy, dimensional stability, resistance to tearing, and adaptability to oral structures) should be considered. For example, if the impression is being sent to a laboratory or if the model is not being poured immediately, consider the material's ability to maintain its integrity while being stored and transported. Certain materials distort shortly after the impression is captured. One of the reasons many dentists use polyvinyl siloxanes and polyethers is because of their ability to maintain their dimensional accuracy for 1 to 2 weeks after taking the impression.[1] These materials also should be able to withstand disinfection without negatively affecting the impression quality.

Another important consideration is how a material interacts with water. For example, hydrophobic materials, such as polyvinyl siloxanes, should be used in dry conditions to prevent moisture contamination that can result in impression voids.[1] The addition of surfactants to these materials can improve their workability in wetter conditions. Polyethers, on the other hand, are considered hydrophilic and are more forgiving when working in wet environments, such as the oral cavity. Elastic recovery (the resistance to distortion after the impression is removed from a patient's mouth) and flexibility (the ease of impression removal) also are desirable characteristics. According to Rubel, polyvinyl siloxane has the best elastic recovery and is considered to have "fairly stiff" flexibility, whereas polyethers have less elastic recovery than polyvinyl siloxanes and are more "rigid."[1]

Dispensing. When choosing among impression materials, practitioners also should consider how the material is dispensed. For materials that require manual mixing, training is necessary to ensure the process is performed correctly. The training, along with the actual mixing of the material, takes time. To save time, some practitioners may choose to use mechanical dispensers with premade cartridges that mix the materials automatically. Although this method is easier to use, it requires an investment in additional equipment that costs money and takes up space.

Set times. Another important factor is the time it takes for the impression material to set. Different types of impression materials have different setting times. Those that take a long time to fully set can result in an uncomfortable experience for a patient, particularly if the patient has an overactive gag reflex.

Hybrid materials. Recently, developments in elastomeric technologies have given rise to a hybrid of polyvinyl and polyether called polyvinyl ether silicone (PVES). Several studies have found that PVES is hydrophilic and has high wettability and tear resistance, while remaining clinically stable after being stored for 2 weeks and disinfected for 30 minutes in glutaraldehyde.[2]

In an in vitro study by Pandey et al, investigators evaluated various mechanical properties of PVES and compared it with polyvinyl siloxane and polyether, including both light and heavy body consistencies for all materials. This study found that PVES is "more flexible and possesses high-tensile strength," although the authors noted that the study was completed in vitro and that intraoral conditions were not simulated.[2]

A study by Re et al. also reported some favorable characteristics of PVES materials. This study compared the physical properties of 12 polyvinyl siloxanes, 2 polyethers, and 3 PVES materials. The findings illustrated that the PVES is comparable to the polyvinyl siloxanes in that they both showed higher results for tensile strength at break and yield strength than the polyethers studied.[3]

Clinician Skill and Tray Selection

Although many modern materials may yield accurate impressions, they are not without fault, and their success depends on the skill level of the practitioner. While taking a traditional impression, the practitioner must be careful to avoid bubble formation that can distort the margin. Removing the impression material also must be done with care to avoid stretching the material or dislodging other fixed restorations.

Another factor that must be taken into consideration when using conventional impression techniques is proper tray selection. Improperly fitting trays can result in inaccurate impressions. The triple tray is one of the more popular options. When used correctly, it efficiently captures both arches while simultaneously registering the patient's bite. But using the wrong size tray or placing the tray incorrectly can distort the impression or result in an inaccurate bite registration. Proper tray selection and placement are vital to capturing an accurate impression.

Lab Approval

After the impression is taken and approved by the dentist, it is sent to the lab. At this point, the lab technician will determine whether the impression is acceptable to fabricate the restoration. If the impression passes muster, the lab will make the restoration and send it to the dentist for cementation. If the impression is unacceptable, the lab will request a new impression. In this case, the practitioner will have to see the patient for a second appointment to retake the impression. The end result is additional expense for the dentist in both chair time and materials, and an additional inconvenient appointment for the patient.

Temporary Crowns

Assuming everything goes smoothly, the process of sending impressions to the laboratory, fabricating the restoration, and receiving the restoration from the lab typically takes more than 2 weeks. During this time, the patient wears a temporary crown to prevent the tooth from breaking or shifting. Temporary crowns can be made using prefabricated shells, the block temp technique, or various other methods. Regardless of the method, they are called temporaries because they are not designed for long-term use. Anyone who has had experience with temporary crowns can attest to the fact they are prone to breaking and debonding. In either case, the dentist bears the expense of additional chair time and materials, while the patient endures yet another inconvenient appointment. In the worst-case scenario, issues with the temporary may result in tooth movement and a poorly fitting permanent restoration.

When each step is done correctly, the traditional analog workflow can produce clinically acceptable restorations. However, inherent variables exist throughout this workflow that may cause errors such as inaccurate impressions, faulty temporaries, and ill-fitting restorations. The digital workflow offers a faster and more accurate alternative to the analog workflow. We will spend the remainder of our time discussing this workflow.

Digital Workflow

Let's begin by comparing the modern digital approach with the traditional workflow.

Taking the Impression

After the patient is numbed and the crown preparation is completed, an impression is taken using a digital intraoral scanner. Similar to an analog impression, the margin must be clearly visible and gingival retraction may be required. Once the digital impression is captured, it is available for immediate review by the practitioner. This method, however, is completed without using bad-tasting impression material that can cause gagging and produce an uncomfortable experience for the patient. The dentist can check for any inconsistencies using features in the imaging software, such as magnification, to evaluate margins more precisely. If a retake is needed, it is accomplished without using costly material and inflicting further discomfort on the patient by forcing them to sit through another uncomfortable impression.

Lab Approval

After an impression is deemed acceptable, it can be saved digitally and sent electronically to the laboratory. This gives the lab technician instant access to the impression, even allowing for a review on the spot, if needed, while the patient is still in the chair.

Restoration Fabrication

If the dental practice has a CAD/CAM system with a milling machine, the final restoration is made in-office, eliminating the need for a temporary crown. The digital crown design is sent to the milling machine, where the final restoration is milled and ready for delivery in 15 to 30 minutes, depending on the material used.

This digital workflow allows patients to have a final indirect restoration cemented in about 90 minutes from start to finish. It doesn't require an extra cementation appointment or waiting for the laboratory to fabricate and send the restoration.

In this example, one can clearly see the advantages of having a digital workflow. In the next section, we will dive deeper into digital impression technology.

Digital Impressions

Digital impression systems have revolutionized modern dentistry. Although the focus of this course is on indirect restorations such as crowns, digital impression systems have other clinical indications, including in implantology and in denture and orthodontic appliance fabrication. Digital impressions can help eliminate some of the problems associated with traditional impressions. As discussed in the preceding section, issues such as faulty tray selection, separation of impression material from the tray, and distortion of the impression before the model is poured, may compromise the final restoration.[4] These complications, which are inherent in the conventional workflow, do not arise when taking digital impressions.

Another important advantage of digital impressions is the ability to accurately replicate models. Consider a situation where a model is broken or poured incorrectly, and the practitioner or lab technician needs to remake the model. In the traditional workflow, the new model can be made by reusing the old impression, assuming that it was stored properly and not distorted in the process.

That is a big assumption because impression materials can lose their integrity over time or when exposed to certain disinfectants. If the impression is no longer viable, or if it was discarded prematurely, the clinician must take a new impression. A new impression is an expense to the dentist and an inconvenience both to the dentist and the patient. In the digital workflow, the original impression is easily accessible because it is stored electronically, so it is not subject to distortion, and it does not require physical storage space.

Digital impressions can be used either by extraorally scanning models obtained using traditional impression techniques or by intraorally scanning the patient directly. In the early days of these systems, scanning models were preferred because intraoral digital scanners were time consuming and not as accurate.[5] As the technology improved, direct intraoral scanning became the norm. In a review of digital impression systems and their use in the fabrication of restorations, Takeuchi et al. discussed several studies that showed that the total time needed for digital impressions was less than the time needed for conventional impressions.[5] The same review also noted two studies that found ceramic restorations made with intraoral scans were equal or superior to their counterparts fabricated from conventional impressions with regard to interproximal contact and occlusal point quality.[5]

Patients also prefer digital impressions to traditional impressions. A study by Yuzbasioglu et al. compared impression techniques in 24 patients (12 men and 12 women) with respect to patience and comfort.[6] In this study, the patients were initially subjected to conventional maxillary and mandibular arch impressions using a polyether along with a polysiloxane bite registration. Two to 3 weeks later, the patients presented for digital impressions using a chairside CAD/CAM system. The patients were then asked to complete a standardized questionnaire and evaluate their perceived source of stress using the State-Trait Anxiety Scale with respect to each impression type. The investigators found that the reported treatment time for digital impressions was significantly less than for traditional impressions, and that all participants in the study preferred digital impressions over traditional impressions.[6]

Given their advantages over traditional impressions, it is not surprising that digital impression systems have become more popular among practitioners. They have many indications in general dentistry as well as in other specialties. Today's digital technology allows clinicians to capture accurate impressions, ensuring precisely fitting restorations. These systems also can help clinicians save valuable chair time and storage space, while providing patients with a more pleasant impression experience.

Some practitioners have taken digitization to the next level and combined digital impression systems with in-office CAD/CAM technology. CAD/CAM dentistry has helped streamline indirect restoration fabrication by removing the lab from the equation and by providing patients with comfort and convenience. We will now explore the advantages of CAD/CAM systems.

CAD/CAM Systems

Although CAD/CAM systems may seem like a recent advancement (possibly due to their current rise in popularity), they have been around for half a century. François Duret used CAD/CAM in the field of restorative dentistry in 1971, and CEREC introduced the first chairside system in 1985.[7,8] Since then, the technology has evolved and is now routinely used to manufacture a variety of restorations, including inlays, onlays, full-coverage crowns, multiunit bridges, veneers, and implant abutments and crowns.

Clinician Control

Earlier, we discussed some of the benefits of a full digital workflow. These benefits include fast production time for the final restoration, eliminating the temporary restoration, and completing the process in one appointment. These advantages are just the tip of the iceberg. An inherent perk of CAD/CAM is that it gives the practitioner full control over the design of the restoration. Because design modifications can be made instantly, the dentist can consult with the patient and make immediate adjustments to achieve the optimal esthetic result. This eliminates the need to consult with a lab technician and reduces the chances of miscommunication about a desired outcome.

Restoration Quality

CAD/CAM systems produce high-quality restorations. Several studies have evaluated the quality of digital restorations, and although specific results vary depending on the system and restorative materials used, evidence supports using CAD/CAM systems for various types of restorations. One study completed at the University of Michigan School of Dentistry evaluated the clinical performance of lithium disilicate crowns made using chairside CAD/CAM fabrication. This study involved 43 participants with a total of 62 crowns (20 premolars, 42 molars) milled using a prefabricated block of IPS e.max CAD (Ivoclar Vivadent) and the CEREC 3 system (Dentsply Sirona).[9] Two independent evaluators assessed the crowns immediately after cementation and again after 6 months, 1 year, and 2 years. Factors such as margin adaptation, fractures, caries, and discoloration were evaluated. The lithium disilicate crowns performed well throughout the study with no cases of surface chipping or crown fracture noted.[9] There were no reports of postop sensitivity at the 1- or 2-year recall visits.[9]

CAD/CAM Materials

To expand digital technology to fabricate a wider range of products, new materials were developed. When it was first introduced to the market, CEREC was designed to manufacture inlays from feldspathic ceramic blocks.[10] As the demand for fabrication of onlays and crowns increased, reinforced ceramics were developed.[11] CAD/CAM systems continue to become more and more sophisticated. Advances in milling mechanisms have improved the quality of restorations while decreasing their milling times. The change from traditional milling discs to diamond burs has helped contribute to these improvements.[12] Practitioners now have access to a wide range of materials, giving them the autonomy to choose materials on a case-by-case basis.

Although many in-office CAD/CAM systems are capable of milling metals, such as cobalt-chromium alloys and titanium, they are not commonly used for same-day restorations due to factors such as lack of esthetics. Newer block materials have been developed to provide strength comparable to metal, while maintaining esthetics. High-strength ceramics, such as lithium disilicate and zirconia, are an attractive option for posterior restorations that require strength. For example, IPS e.max (Ivoclar Vivadent) is a monolithic lithium disilicate ceramic that produces restorations with a flexural strength of 500 MPa.[13] These blocks can be used to fabricate both anterior and posterior single-unit crowns, inlays, onlays, and even 3-unit anterior bridges.[14] CEREC Tessera (Dentsply Sirona) is an advanced lithium disilicate block with a flexural strength of 700 MPa and an oven-processing time of only 4.5 minutes in a SpeedFire oven (Dentsply Sirona), making it the highest-strength glass ceramic on the market. It can save clinicians up to 44% of total processing time.[15]

Several companies, such as Dentsply Sirona, VITA, and Ivoclar Vivadent, produce zirconia blocks with flexural strengths over 1,000 MPa that produce strong posterior restorations.[10] Some chairside zirconia restorations are suitable for small bridges, but have limited esthetics because of low translucency.[14] Some blocks offer blends of materials to combine the desired benefits of each individual component. For instance, the CEREC Tessera block incorporates lithium disilicate, for improved strength, and virgilite, for enhanced esthetics, within a glassy zirconia matrix.[15]

One of the most esthetic options available for anterior dentition is feldspathic porcelain. Although beautiful, this material is not as strong as other options, such as zirconia or lithium disilicate, and has a biaxial flexural strength of only approximately 150 MPa.[13] Despite this limitation, the material is a popular option for teeth in the esthetic zone and is available as a monochromatic or polychromatic block, the latter allowing for more customizability.

Resin-based blocks, available for partial- and full-coverage restorations, provide increased flexibility due to their resin component.[13] As described by Puri, these blocks can be divided into two main categories: resin-based, zirconia-reinforced nanoceramic blocks (including LAVA Ultimate [3M] and CERASMART [GC America]) and hybrid ceramic (such as VITA ENAMIC [VITA]).[13] Although ideal for partial-coverage restorations, the increased flexibility of some of these materials can present a challenge for full-coverage restorations. As with all restorations, following the appropriate cementation protocol can help prevent debonding.[16]

Conclusion

Advancements in technology and materials have transformed restorative dentistry. With the modern digital workflow, indirect restoration fabrication is a streamlined, predictable process. For dentists, this means efficiency and control. For patients, it means comfort and convenience. As with anything new, CAD/CAM dentistry will require an initial investment of time and money. Most practitioners will see an immediate and ongoing return on that investment in the form of increased treatment acceptance, decreased lab bills, and improved treatment outcomes.

Case Study

A 28-year-old female patient with no significant medical history presented with a failing restoration on tooth #3, and radiographic mesial and distal caries (Figures 1 and 2). She complained of pain when chewing. Based on the reproducible pain and evidence of extensive decay, we chose to restore the tooth with a full-coverage ceramic crown. A CEREC Tessera MT A2 block (Dentsply Sirona) was selected because of its high strength.

After anesthetizing the patient with 1 carpule of articaine, the tooth was reduced to allow for at least 1 mm of material thickness for the crown. The old amalgam, decay, and fracture lines were removed under isolation (Figures 3 and 4).

The final preparation was scanned with Primescan using CEREC Software 5.1.3, and the crown was designed and milled on CEREC MC XL (Figures 5-9). The sprue was removed and the crown was stained and glazed using Celtra Duo paint-on glaze and stains (Dentsply Sirona) (Figures 10 and 11). The crown was then placed in the CEREC SpeedFire for about 4 minutes to achieve full strength (approximately 700 MPa) (Figures 12 and 13).

Figure 1—Preop tooth No. 3 with mesial marginal ridge fracture, recurrent decay, and pain on chewing

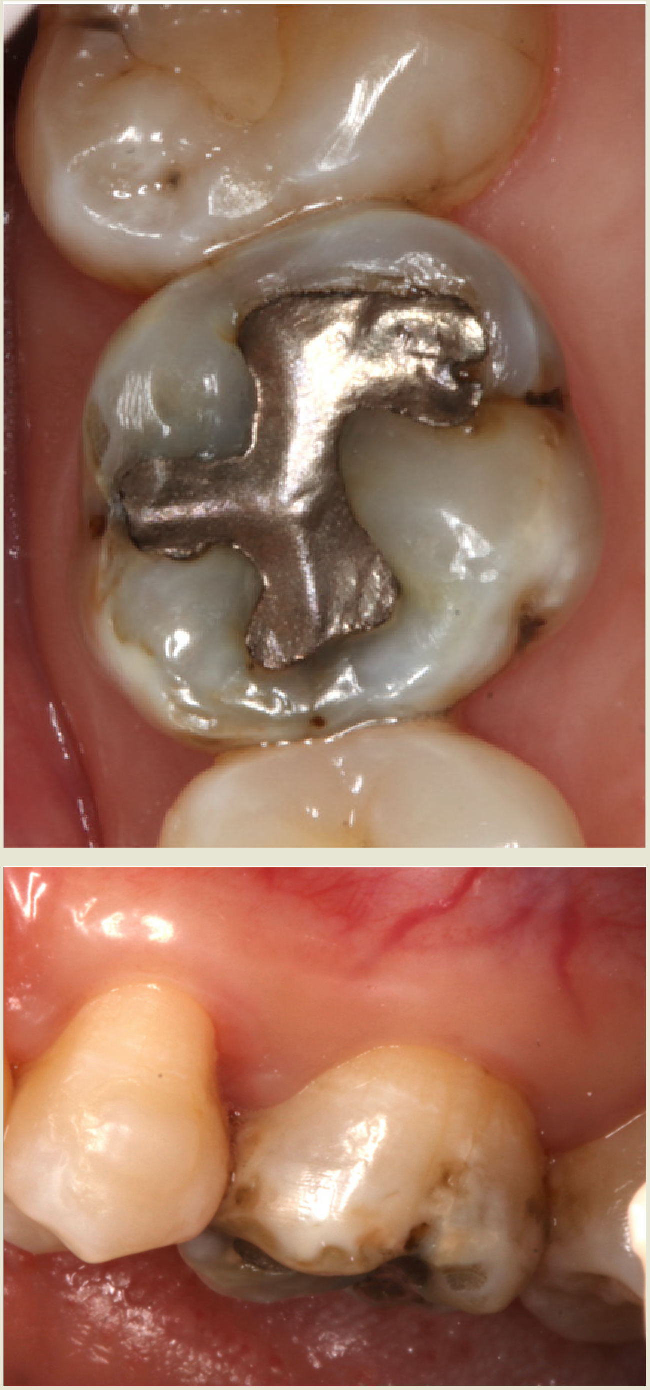

Figure 2—Occlusal and buccal views of tooth No. 3

Figure 3—Crown preparation of tooth No. 3

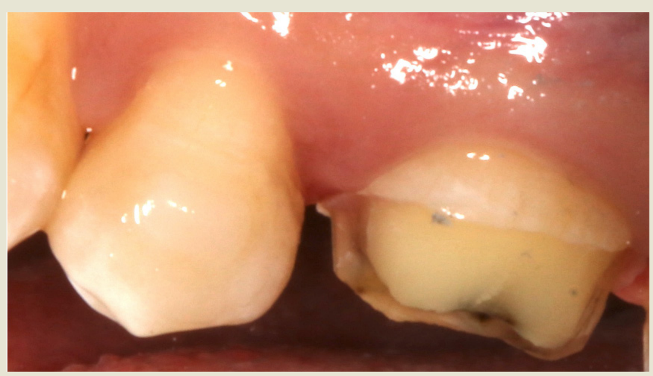

Figure 4—Buccal view showing supragingival preparation

Figure 5—Primescan image and margination of tooth No. 3

Figure 6—Primescan image from buccal of tooth No. 3

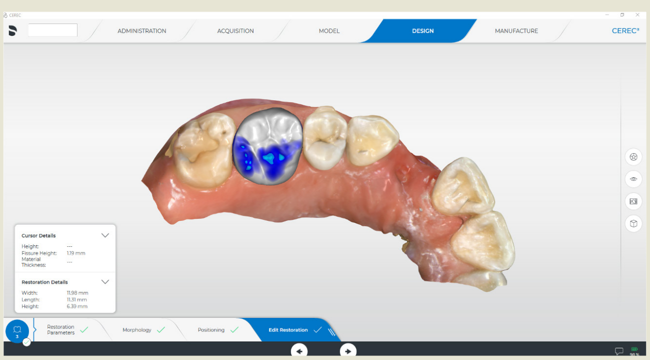

Figure 7—Primescan crown design in CEREC Software 5.1.3

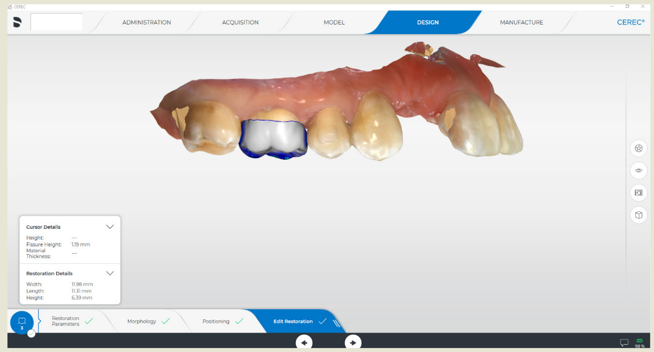

Figure 8—Primescan buccal view of crown design

Figure 9—Crown design in CEREC Software 5.1.3 manufacture phase

Figure 10—CEREC Tessera block 700 MPa flexural strength

Figure 11—Milled CEREC Tessera crown using Primemill

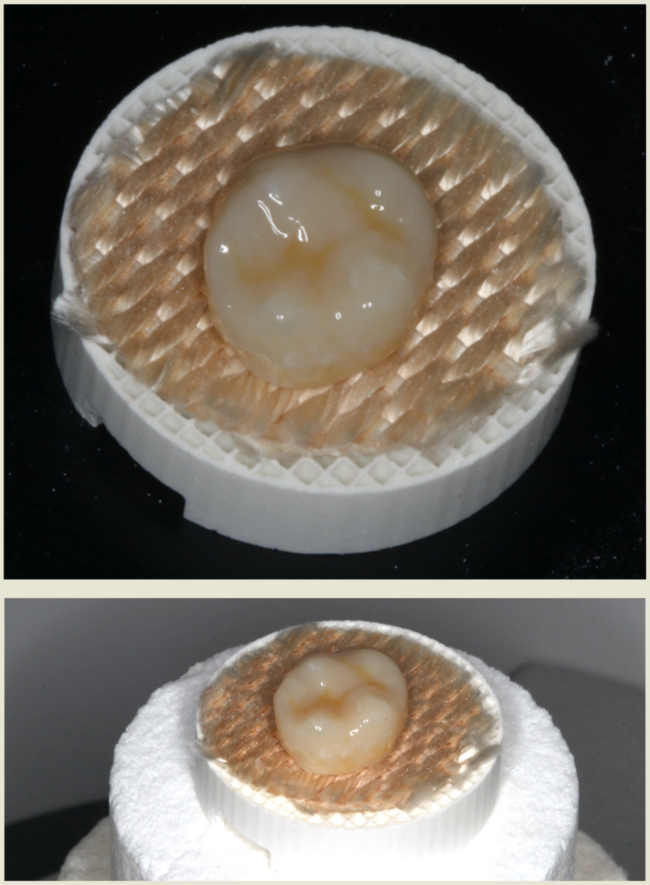

Figure 12—CEREC Tessera crown with stain and glaze applied in CEREC SpeedFire oven

Figure 13—Completed fire cycle in 4.5 minutes in CEREC SpeedFire oven

Figure 14—Postop bonded crown No. 3 with Calibra Universal Cement

Figure 15—Postop bonded crown No. 3

Figure 16—Pre- and postop buccal view showing translucency and blending of crown

The crown was tried in, treated with hydrofluoric acid and silane, and bonded using Calibra Universal cement (Dentsply Sirona) (Figure 14).

No restoration adjustments were necessary, and total treatment time was 60 minutes (Figures 15 and 16).

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1. Indirect fixed restorations include which of the following?
a. Full-coverage crowns
b. Inlays
c. Onlays
d. All of the above

2. The most common impression materials for indirect fixed restorations include which of the following?
a. Polyvinyl siloxanes
b. Alginate
c. Hydrocolloids
d. All of the above

3. Ideal impression materials should possess which of the following characteristics?
a. Dimensional instability
b. Resistance to tearing
c. Inability to adapt to oral structures
d. None of the above

4. Polyvinyl siloxanes are hydrophobic, while polyethers are hydrophilic.
a. True
b. False

5. Polyvinyl ether silicone has which of the following properties?
a. Hydrophobic
b. Low wettability
c. High tensile strength
d. All of the above

6. Needing to retake an impression using conventional impression materials can result in which of the following?
a. Increased material costs
b. Wasted chair time
c. Return office visit for the patient
d. All of the above

7. Digital impressions do not require gingival retraction.
a. True
b. False

8. Digital impressions can be used to fabricate which of the following?
a. Indirect restorations
b. Dentures
c. Orthodontic appliances
d. All of the above

9. Which of the following problems associated with traditional impressions is eliminated when using digital impression systems?
a. Incorrect tray selection
b. Improper gingival retraction
c. Both A and B
d. Neither A nor B

10. Which of the following is a benefit of digital impressions?
a. Less space required for storage
b. Faster delivery to laboratory
c. Ease of replication
d. All of the above

11. A review by Takeuchi et al. discussed studies that found which of the following?
a. Total time needed for digital impressions was more than traditional impressions.
b. Ceramic restorations made with intraoral scans were equal or superior to counterparts made with traditional impressions in regard to interproximal contact quality.
c. Ceramic restorations made with intraoral scans were inferior to counterparts made with traditional impressions in regard to occlusal point quality.
d. None of the above

12. A study by Yuzbasioglu et al. comparing digital with conventional impressions found which of the following?
a. Total treatment time of the digital impressions was significantly less.
b. Total treatment time of the digital impressions was significantly more.
c. Total treatment times were equal.
d. None of the above

13. The same study by Yuzbasioglu et al. found that participants preferred which type of impression?
a. Digital
b. Traditional
c. Patients preferred them equally
d. None of the above

14. A systematic review by Nagarkar et al. investigating full-coverage restorations fabricated using both digital and traditional impression techniques found similar results in marginal and internal fit between the two, although the quality of evidence was deemed low.
a. True
b. False

15. The same review by Nagarkar et al. clearly demonstrated the superiority of digital impressions and illustrated that no further studies need to be done on the topic.
   a. True
   b. False

16. In what year did François Duret first introduce CAD/CAM systems to the field of restorative dentistry?
   a. 1951
   b. 1961
   c. 1971
   d. 1981

17. In what year did CEREC implement the first chairside CAD/CAM system?
   a. 1975
   b. 1985
   c. 1995
   d. 2005

18. Which of the following are potential advantages of CAD/CAM systems?
   a. Reduced labor time
   b. Improved cost effectiveness
   c. Improved quality control
   d. All of the above

19. Which of the following are potential disadvantages of CAD/CAM systems?
   a. Expensive upfront cost
   b. Time for training
   c. Money for training
   d. All of the above

20. A study completed at the University of Michigan School of Dentistry evaluating lithium disilicate crowns fabricated using CAD/CAM found which of the following?
   a. No crown fractures
   b. Significant surface chipping
   c. Postop sensitivity at 1-year recall
   d. None of the above

21. When first introduced, the original CEREC system was designed to fabricate inlays from feldspathic ceramic blocks.
   a. True
   b. False

22. The CEREC Tessera block can save clinicians up to what percentage of total processing time?
   a. 34%
   b. 44%
   c. 54%
   d. 65%

23. How many minutes of firing does the CEREC Tessera block require when using the CEREC SpeedFire furnace?
   a. 2.5 minutes
   b. 3.5 minutes
   c. 4.5 minutes
   d. 5.5 minutes

24. High-glass porcelain blocks offer high esthetics and have a biaxial flexural strength of approximately what?
   a. 150 MPa
   b. 250 MPa
   c. 350 MPa
   d. 450 MPa

25. Resin-based blocks are known for which of the following?
   a. Increased flexibility
   b. Increased malleability
   c. Poor esthetics
   d. None of the above

26. LAVA Ultimate and CERASMART blocks are examples of which of the following?
   a. High glass porcelain
   b. Hybrid ceramic
   c. Lithium disilicate
   d. Resin-based, zirconia-reinforced nanoceramic block

27. Which of the following is an example of a monolithic lithium disilicate ceramic?
   a. LAVA Ultimate
   b. CERASMART
   c. VITA ENAMIC
   d. IPS e.max

28. IPS e.max has a flexural strength of approximately what?
   a. 400 MPa
   b. 500 MPa
   c. 600 MPa
   d. 700 MPa

29. Zirconia blocks produce restorations strong enough for which of the following?
   a. Anterior crowns
   b. Posterior crowns
   c. Small bridges
   d. All of the above

30. The CEREC Tessera block incorporates lithium disilicate and virgilite within a zirconia matrix.
   a. True
   b. False

INDIRECT RESTORATIONS THEN & NOW: A COMPARISON OF ANALOG & DIGITAL WORKFLOWS

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EDUCATIONAL OBJECTIVES

1. Distinguish the similarities and differences comparing traditional, digital, and CAD/CAM impression techniques
2. List the differences among current impression materials
3. Describe how digital impressions and CAD/CAM technology can improve efficiency
4. Explain how digital and CAD/CAM technology relates to patient care and acceptance.

COURSE EVALUATION

Please evaluate this course using a scale of 1 to 5, where 1 is poor and 5 is excellent.

1. Clarity of objectives . . . . ① ② ③ ④ ⑤
2. Usefulness of content . . . . ① ② ③ ④ ⑤
3. Benefit to your clinical practice. ① ② ③ ④ ⑤
4. Usefulness of the references . . . . ① ② ③ ④ ⑤
5. Quality of written presentation . . . . ① ② ③ ④ ⑤
6. Quality of illustrations . . . . ① ② ③ ④ ⑤
7. Clarity of quiz questions . . . . ① ② ③ ④ ⑤
8. Relevance of quiz questions . . . . ① ② ③ ④ ⑤
9. Rate your overall satisfaction with this course . . . . ① ② ③ ④ ⑤
10. Did this lesson achieve its educational objectives? ◯Yes ◯No
11. Are there any other topics you would like to see presented in the future? ____________________
12. Overall administration of the program . . . . ① ② ③ ④ ⑤

QUIZ ANSWERS

Fill in the circle of the appropriate answer that corresponds to the question on previous pages.

1.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	16.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
2.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	17.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
3.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	18.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
4.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	19.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
5.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	20.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
6.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	21.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
7.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	22.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
8.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	23.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
9.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	24.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
10.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	25.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
11.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	26.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
12.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	27.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
13.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	28.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
14.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	29.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
15.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	30.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ

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