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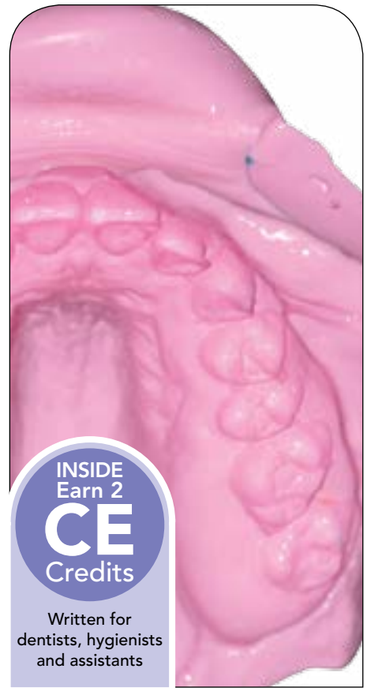
DENTAL LEARNING *Quarterly*

Knowledge for Clinical Practice

Narrow-Diameter Implants: *A Minimally Invasive Solution for Overdenture Treatment*



The Selection, Use and Accuracy of Alginate Impression Materials

Caries Risk Assessment: *Treatment Planning and Prevention*

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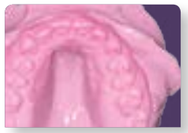
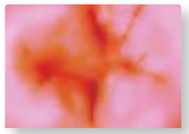
CONTINUING EDUCATION





CASE STUDY

REVIEW ARTICLES

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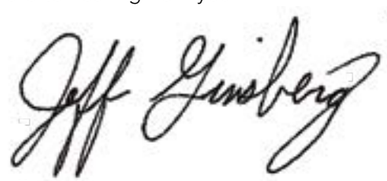
DENTAL LEARNING *Quarterly*

Knowledge for Clinical Practice

Welcome to our third issue of *Dental Learning Quarterly* in 2015. In this issue, you'll find three CE articles: Dr. Paresh Patel reviews the use of narrow-diameter implants, together with overdentures, as a treatment option for edentulous patients. In the second article, Dr. Stan Presley and Dr. Jaimee Morgan offer a practical review on the selection, use, and accuracy of alginate impression materials, including a thorough review of alginate impression-taking along with practical tips for application. And in the third CE article, Dr. Bernadette Alvear Fa and Dr. Douglas Young discuss caries risk assessment, treatment planning, and prevention.

In addition to these opportunities to earn CE credits, we've included three additional articles. The first is a case study by Dr. John Comisi, who discusses the use of preformed composite veneers to address the esthetic needs of a patient with severe mottling of the central incisors. This is followed by a review article on the proper clean-up of dental cement and methods for removing excess/residual cement following restoration placement. The final article in this issue is by Dr. Shane Ricci on isolation for restorative procedures.

We welcome your feedback and suggestions for future CE articles, reviews, and case studies, and would also like to encourage you to contact us if you have an article or case study that you believe would be of interest to our readers. If you have suggestions or comments, I can be reached at jginsberg@dentalproductshopper.com. I look forward to hearing from you.



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Narrow-Diameter Implants:
A Minimally Invasive Solution for Overdenture Treatment

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Dr. Paresh B. Patel is a graduate of the University of North Carolina at Chapel Hill School of Dentistry and the Medical College of Georgia/American Academy of Implant Dentistry Maxi Course. He is the co-founder of the American Academy of Small Diameter Implants and is a clinical instructor at the Reconstructive Dentistry Institute with Dr. Ara Nazarian. He enjoys helping dentists incorporate implant dentistry as everyday dentistry into their practices. Dr. Patel has placed more than 3500 small diameter implants and has lectured on this topic in the US, Brazil and Italy. He is also actively involved as a clinical consultant for several implant manufacturers, including ZEST Anchors, LLC, the sponsors of this course.
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EDUCATIONAL OBJECTIVES

The overall goal of this article is to provide the reader with information on the treatment of edentulous patients with overdentures retained utilizing narrow-diameter implants and attachments. After reading this article, the reader will be able to:

1. List and describe considerations in overdenture treatment utilizing implants
2. Describe the concept behind myostatic denture design and how this can be achieved
3. Review the treatment planning for narrow-diameter implants
4. Review and describe the use of attachments with low vertical height.

ABSTRACT

The use of implants in the edentulous arch has changed the way in which patients can be treated. Standard diameter implants have been utilized successfully for more than 20 years for overdenture patients, and more recently narrow-diameter implants have been utilized. Both standard and narrow-diameter implants have demonstrated high success and survival rates and are associated with improvements in function and patient comfort. Narrow-diameter implants offer the opportunity to provide implant-retained overdentures, without additional surgery, to patients who would otherwise require surgical procedures to augment bone prior to implant placement.

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Introduction

A major challenge for today's dental practitioner is how to properly manage the totally edentulous patient. During the 1960s and 1970s, implants started to be placed to satisfy this need; however, success rates were initially relatively poor. The only alternative solution, and the most economical one, was to offer tissue-supported dentures. Even with the best denture design and fabrication possible, and in the presence of adequate support, retention and stability were often issues and sources of patient discomfort and dissatisfaction. With the development of the endosseous root-form implant, this changed. From the 1990s until the present, a favorable treatment option has been the overdenture with two standard diameter implants as proposed by the McGill consensus statement.[1]

By augmenting conventional therapy (complete dentures) with implants, many complications can be reduced. The inability to chew certain foods, denture pain, lack of retention, nutritional deficiencies, collapse of vertical dimension and poor psychological status can be corrected. There are several differing philosophies when utilizing standard body implants, such as location, size, and prosthetic overdenture design. Techniques utilized in the mandibular arch include placing one standard diameter implant in each of the canine or lateral incisor areas. Treatment of the edentulous patient with two standard body implants is well-researched and will, at a minimum, reduce the movement of a conventional lower denture. Implants can also improve chewing efficiency, bite force and quality of life.[2-5] Both maxillary and mandibular implant-retained overdentures have demonstrated high success and survival rates.[6,7] Anatomically, endosseous standard diameter implants can help preserve the alveolar bone.[8] For patients, the use of implants translates into better facial aesthetics, increased self-confidence, and fewer denture sores. With more clinicians embracing overdenture therapy, prosthetic complications associated with complete denture treatment in edentulous patients should decrease. The standard body implant may fulfill the requirement for denture stabilization for many patients.

A standard body implant is approximately 3.75 mm in diameter. The fact that this size was designed as the standard diameter may have had some connection to the average width of a tooth root. To follow the guidelines when placing an implant of approximately 4 mm in diameter, approximately 6 mm of bone width in the facial-lingual dimension is required.[9] However, an edentulous patient may lack sufficient alveolar bone to encase a standard diameter implant with the required 1 mm of bone circumferentially.[10] The bone could be expanded with the use of osteotomes, however there still would not be 1 mm of native bone across the buccal aspect. Alternatively, it would be necessary to perform additional, more-invasive procedures such as a sinus lift or bone augmentation prior to placement of standard diameter implants. With acceptance, a different opportunity is to provide patients with overdentures retained by narrow-diameter implants that satisfy the anatomical/surgical constraints of the patient.

Narrow-Diameter Dental Implants

Narrow-diameter implants (NDIs) are root-form endosseous implants that are less than 3 mm in diameter. As such, they provide a suitable alternative for patients with inadequate bone width for standard diameter implants (Fig . 1).

NDIs were originally designed to stabilize an interim prosthesis while conventional implants osseointegrated. When it was time to remove the NDIs, clinicians found that they had osseointegrated in around 50% of NDIs placed. Subsequently, their design features (macro and micro),

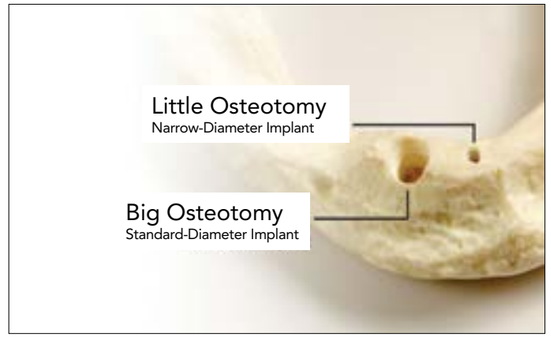

Figure 1. Comparison of osteotomy size with standard and narrow-diameter implants

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insertion protocol and composition (stainless steel vs. titanium alloy) were changed. They are now typically made with the same Ti alloy and the same surface treatments as standard diameter implants. In 1997, NDIs were cleared by the FDA for "long-term intrabony applications."[11]

The macro design of most NDIs is a deep V pattern. This affords greater initial bone-to-implant contact (BIC), initial stability, and a wider platform to dissipate occlusal forces. The micro design of NDIs now includes a rough surface to promote osseointegration. A study at Loma Linda University demonstrated this with a core sample of bone and implant 8 months after insertion with BIC similar to that of standard diameter implants.[12] The insertion protocol for NDIs has been simplified. Typically, one or two drills are used to make an undersized osteotomy and let the self-advancing, bone-condensing and compressing design of the implant draw itself into the dense bone. All these features in combination can allow the NDI to be immediately loaded in the edentulous mandible.[13] However, osseointegration will not occur without stability, and a minimum of 30 Ncm of torque should be achieved before considering loading the implant.[14] Since the body of the implant is narrow, this almost always ensures that it will be placed in good bone with two cortical places for support and immediate immobility (Fig. 2). With a minimal amount of surgery, immediate circulation of blood and all the necessary healing factors occur quickly. This one-stage surgery with narrow-diameter implants is becoming more accepted.

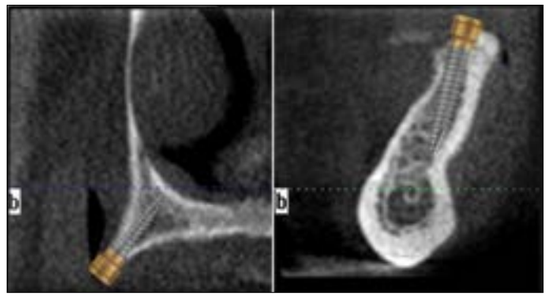

Figure 2. Narrow-diameter implants superimposed in areas with narrow bone

It has been estimated that 25% of patients who would benefit from implants do not do so because of inadequate bone, financial constraints, time constraints, or compromised physical conditions.[15] NDIs by design are minimally invasive, particularly when compared with alternative treatments such as bone augmentation or sinus lifts prior to implant placement; they can be placed with a single-stage flapless surgery protocol; and they are less expensive than standard diameter implant treatment with overdentures.[16-18] Over the past decade, several studies have shown promising survival rates for tissue-supported overdentures retained by NDIs. One study found a survival rate of 90%, while two separate studies found higher survival rates. In the first study of 5 years' duration, 2,514 NDIs were placed for fixed and removable prostheses (with similar numbers of each type of prosthesis). The overall survival rate was 94.1% with a mean follow-up period of 2.9 years.[19] A later report on 5,640 NDIs placed in 1,260 patients over a 12-year period with a mean follow-up period of almost four years found a survival rate of 92.1%.[20] Results have also demonstrated increased retention, stability, and patient comfort with NDI-retained overdentures.[21] Removable partial dentures can also be retained with NDIs.[21] By utilizing NDIs for removable prostheses, the need to prepare adjacent healthy tooth structure for a precision attachment is often unnecessary (Kennedy Class I or II). Distal extensions can be kept from rocking while anterior sections of missing teeth can be replaced with greater esthetic results by removing the facial clasps (Kennedy Class IV).

Not only can the removable prosthesis be stable, well-retained and retained esthetically, the implant will also help preserve the residual alveolar bone. Without implants, the edentulous areas will continue to atrophy. NDIs have also been shown to be effective for fixed prostheses. A seven-year retrospective study by Vigolo et al. followed 165 patients where 192 NDIs were placed to support single-tooth and multiple-implant restorations that were either cement-retained or screw-retained prostheses. A survival rate of 95.3% was reported.[22] In recent years, NDIs have also been successfully utilized during orthodontic treatment for temporary anchorage (Table 1).[23,24]

The focus of the remainder of this article is on the tissue-supported, NDI-retained overdenture.

Table 1. Uses for NDI
Mandibular complete denture
Maxillary complete denture
Single tooth replacement
Mandibular partial denture
Maxillary partial denture
Multiple missing teeth

Myostatic Denture Design

The primary goal for placing NDIs is to provide *retention* for a well-constructed full denture. The denture must be planned and executed correctly for long-term stability, success, and, ultimately, increased quality of life and satisfaction for patients. It must be tissue-supported on myostatic landmarks and have bilateral stability when in occlusion and function. Denture stability is strongly influenced by the denture's occlusion, which must be designed to avoid movement and tilting of the dentures when the opposing arches are in contact.[25] If these goals are accomplished, four correctly placed NDIs in the mandible and six NDIs in the maxilla will provide retention and result in patient satisfaction. It has often been said that implant dentistry is a prosthetic discipline with a surgical component. With that as our guiding principle, we begin with records that respect the myostatic design.

Myostatic principles are used to identify the areas in the edentulous mouth that will not move when swallowing, opening, closing or speaking. If dentures are constructed to this extension, they will be stable;[26] if built past these areas, they will move (myodynamic). Dentures with overextensions past these anatomical landmarks will create sore areas, will float and will be dislodged during function. In the maxilla, the hard palate, alveolar ridges, and tuberosity are myostatic. An impression that captures these areas with correct vestibular extension will be sufficient to create a stable denture (Fig. 3).[26] A stable maxillary denture should not be confused with a retentive one. Well-constructed maxillary dentures can still have little to no retention. The only way to add retention in these situations is to place implants. The mandibular arch is the opposite. With several muscle attachments, any overextensions will cause lifting of the denture. A full-arch impression is taken and poured in dental stone for evaluation and identification of all the important anatomical landmarks.[27] If any of these landmarks are missing, one must retake the impression and capture those.

There are several steps to taking an accurate impression and then utilizing this for mandibular models and an accurate record for an edentulous patient:

- With a pencil, an elliptical line is drawn around the retromolar pad, which is fibrous connective tissue, and provides stability for the distal extension of the denture (Fig. 4)
- On the lingual side of the cast, the mylohyoid ridge is

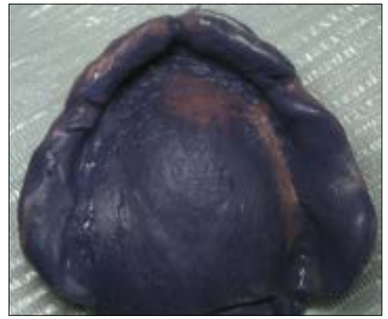

Figure 3. Upper impression

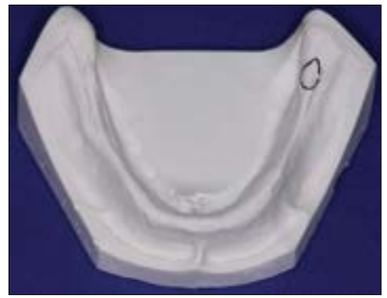

Figure 4. Mandibular model

then identified and marked. Any extension beyond this ridge will cause the denture to lift during function as the floor of the mouth rises (Fig. 5).

- Next, the external oblique ridge is identified on the facial side of the cast. This usually runs from second molar to second premolar. In the edentulous patient, the buccinator fibers detach as the alveolar bone resorbs and only remain attached to the mandible lateral to the external oblique ridge. If the denture base is kept even with the external oblique ridge, there is no possibility of the denture dislodging or creating sore areas as a result of the buccinator muscle contracting during function.
- Easy landmarks such as the buccal and lingual frena are drawn in with a "V" mark. The mentalis is drawn in with oblong circles. With all the landmarks identified, the lines are connected. Particular care should be taken when connecting the retromolar pad to the external oblique ridge. The form should be a shallow curve to the anterior of the cast, to ensure that the denture base avoids the masseter muscle fibers (Fig. 6).

Once the locations of the extensions for the denture base are known, the only definitive way to transfer this information into the denture is to make a scribe line. Any team member can do this, from the assistant to the laboratory technician. A pointed instrument can be used and a line scribed 1 mm outside the line already drawn on the cast. If done in this manner, the laboratory technician can trim the denture after processing. The extensions of the denture will be exactly to the pre-determined myostatic finish line. The denture will be extremely stable, have less potential for sore spots, and offer good function.

Diagnosis and Treatment Planning

As stated earlier, overdenture therapy is a prosthetic discipline with a surgical component. When beginning a case, it is important to know where final tooth position, flange extensions and implants will be placed prior to placing implants. This can be achieved by creating a well-constructed mockup of the final denture in wax prior to implant placement. If the patient has a well-fitting denture, it can be duplicated very easily in one appointment with impression putty (Fig. 7). This duplicate denture can be used to help assess whether, if implants are placed in the key positions, there will be adequate room for the retentive housing and proper function and to allow for an esthetic result. Evaluating the available bone is easily performed with a panoramic radiograph and a set of study models. The radiograph aids assessment of how much vertical height of bone is available for the implants and aids treatment planning. The radiograph will not provide information on how much bone, and its volume, in the other three planes: anterior, posterior, and lateral. This is where the study models and ridge mapping are critical. The volume of bone for implant placement can also be evaluated with 3-D cone beam CT. Prosthetic planning considerations can be found in Table 2. The technique of ridge mapping is explained below.

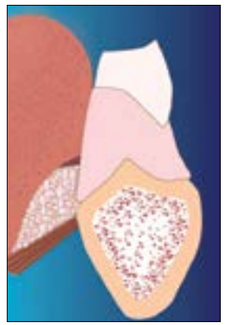

Figure 5. Anatomy of mylohyoid ridge region

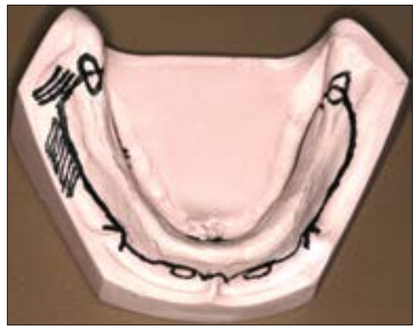

Figure 6. All anatomical landmarks connected on mandibular model

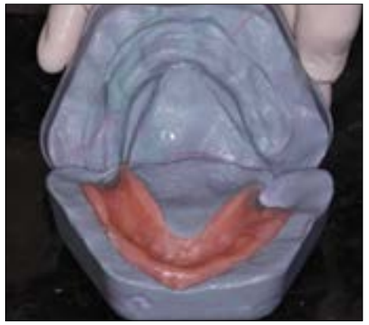

Figure 7. Denture duplication with putty

Ridge Mapping

Four NDIs can be placed in positions between the mental foramena (A B D E positions) (Fig. 8). A fifth NDI can also be placed in position C if preferred. With the patient anesthetized and the key implant positions identified between the mental foramena, ridge mapping begins. Two measurements are made on the facial aspect, one on the crestal aspect and two on the lingual aspect of the residual alveolar ridge. This is performed using a periodontal probe to penetrate the soft tissue until bone is felt (Fig. 9). The assistant should record the depth on a chart that depicts the location and area. Once all four or five sites have been probed, the data is then transferred to the duplicated study model. The study model is then sectioned in the exact locations proposed for implant placement. A marker is used to transfer the depth marks to the model and the contour of the gingival tissue is colored in. Once this is completed, the exact dimensions of the residual ridge are known. By holding up the available sizes of NDIs, it can be determined which size will work best. Any issues with sloped bone can be identified and plans to flatten ridges can be made prior to surgery. The duplicate denture can also be placed over the cast to see if the proposed location and slope of bone will allow the NDIs to be contained within the prosthesis. If any of these do not meet the clinical requirements, changes can readily be made.

Placement of the four NDIs 5 mm anterior to the mental foramena is ideal to avoid impinging on any anterior loops of the nerve should these be present. That will usually place the distal implants in the premolar or canine region. The other two NDIs will be in the position where the lateral incisors would have been. If the residual ridge is wider and taller than normal, NDI placement behind the foramena can be an option to increase the anteroposterior (A/P) spread (the distance from the midline of the most anterior implant to the distal of the most posterior implants). If there are any frena or muscle attachments that would be impinged on by implant placement in ideal locations, these attachments should be released using a scalpel.

Treatment options for maxillary NDI overdentures are

Table 2. Prosthetic planning considerations
Records
VDO with wax rims
Wax try-in
Esthetics
Phonetics
Jaw relationships
Occlusion
Bilateral stability
Inter-arch restorative space for the NDI and housing

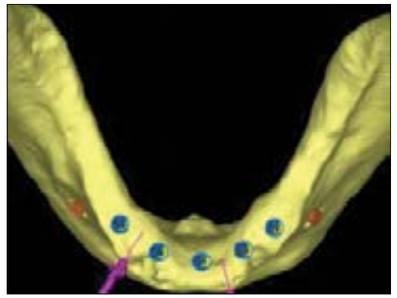

Figure 8. Key implant positions (A B C D E)

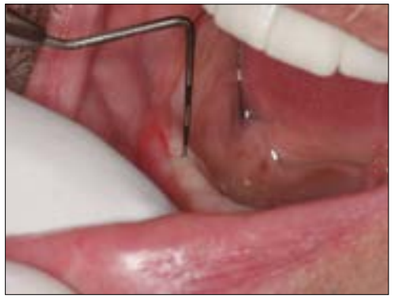

Figure 9. Periodontal probe to assess tissue thickness

different than they are for the mandible. This is primarily because of the biomechanical disadvantages of the maxilla. One treatment option is to utilize six NDIs with a wide A/P spread. In the atrophic maxilla, NDIs will help maintain the residual ridge and are a less expensive treatment option than a fixed prosthesis. Based on the poor success rates reported in the literature and the greater potential for poor bone quality in the maxilla, immediate loading should not be considered without 30 Ncm of placement torque and a full palatal coverage overdenture. If 30 Ncm of placement torque is not achieved, the clinician must consider soft lining the overdenture or replacing the fixture with a larger-diameter implant. While implant number and location are more important than implant size, the use of as large an NDI as possible for the case is encouraged to maximize the implant surface area available for osseointegration and to maximize the potential for bicortical stabilization. The key implant positions in the maxilla should be second premolar, canine, and lateral. The final NDI overdenture should have the same design features as a complete denture – full flanges and a palate that extends back to the tuberosity.

Avoiding Failure with NDIs

Failure with NDIs can be minimized with good treatment planning and consideration of anatomical factors and the number of implants required, as well as by following a precise protocol for the surgical and restorative phases of treatment. Factors to consider include the following:

Soft Tissue Thickness: If the tissue is greater than 2 mm, then consider reducing the tissue height to reduce the lever arm. A long lever arm will create stress on the NDI and can lead to failure.

Parallel Implants: All implants should be placed with great attention to alignment. If greater than 15-20 degrees of divergence is present (system dependent), failure can occur from increased off-axis forces. Patients also report greater difficulty in overdenture placement and removal.

Type of Bone: NDI will fare better in dense bone with little trabeculation. Ridge mapping will help determine the facial-lingual width of bone. NDIs also have better results in Type I and II bone. Use caution in Type III and Type IV bone.

Number of NDIs: In the mandible four implants should be used, and in the maxilla six implants should be used to support an overdenture. The ratio is around two NDIs for every one standard diameter implant that would have been used.

Length of NDIs: No less than 10 mm should be used. The longest length possible should be considered to help increase surface area and provide initial stability.

Early Loading and Occlusion: Most NDIs are immediately loaded. Without 30 Ncm of placement torque, the immediate use of the implant should be questioned and a soft reline should be considered to allow opportunity for osseointegration.

Identification of Critical Anatomy in the Atrophied Mandible

After tooth loss, alveolar bone immediately begins to resorb.[28-30] This is a result of missing impulses from the periodontal tissues into alveolar bone as well as systemic and metabolic factors. After the first year of tooth loss, more than 4 mm in height and 30% in crestal bone width is usually lost. Vertical loss will then continue at a rate of 0.1 mm to 0.5 mm per year.[31] When placing NDIs in the resorbed mandible (Fig. 10), many areas of anatomy are of significant importance. Panoramic and lateral-view radiographs are necessary to identify the mental foramen and the shape, size, and trajectory of the remaining bone. If access to a lateral cephalograph is not possible, a large No. 4 size film can be used. Alternatively, a CT scan can be utilized.

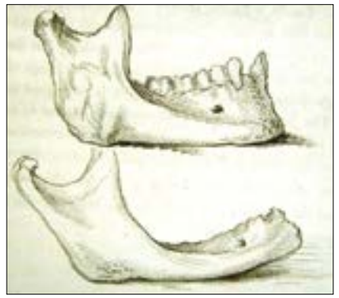

Figure 10. Mandibular resorption
Source: Bells 1806

Mental Foramen: There are several ways to locate the mental foramen. One quick way is to draw an imaginary line from the patient's pupils straight down to the mandible. This gives a general idea of where the inferior alveolar nerve will exit. Another method is to place radiopaque material (e.g., composite, foil, or gutta percha) in the denture near the second premolar location. Then, once the panoramic radiograph has been taken with the denture in place, there will be a visible reference point in relation to the denture. The ball end of a ball burnisher can also be used to "feel" the drop into the foramen; however, this is the most variable of the three techniques.

Lingual Artery and Submandibular Artery: One of the most important things to understand when placing implants is how mandibular bone resorbs. It is a down-and-out pattern toward the chin. Most general dentists are accustomed to the facial flare of the lower incisors. In the edentulous jaw, the pattern is opposite, with the superior crest of bone more lingual and the inferior cortical bone more facial. To avoid penetrating through the lingual plate with the cutting tip of the implant, one must be aware of this trajectory pattern. Using bone calipers or ridge mapping is necessary. An improper angle when placing NDIs with flapless surgery may lead to gross surgical complications. These complications include penetration of the lingual plate and perforation of the lingual or submandibular artery with potentially life-threatening hemorrhage in the floor of the mouth (Fig. 11).

Overdenture Attachments

Advantages of Attachments with Low Vertical Height

A large array of attachment devices is available for implant-retained overdentures, including O-ring balls, Locator attachments and ERA attachments. Due to the one-piece design of most NDIs, these are typically utilized unsplinted for overdentures and designed with an O-ball attachment. This attachment has proven to be effective in most situations.[32] Another option now is the use of NDIs with a self-aligning attachment with low vertical height (the Locator attachment) that is also in use for standard diameter implants. Distinct advantages of this attachment are its ability to compensate for off-angle implants (without using angled abutments), useful in cases where there would have been insufficient vertical space for an O-ball (Fig. 12), and the variable retention that can be provided with these Locator attachments. Implants may diverge up to 20 degrees for up to a total of 40 degrees with two implants and still be able to be restored. In cases where the vertical height

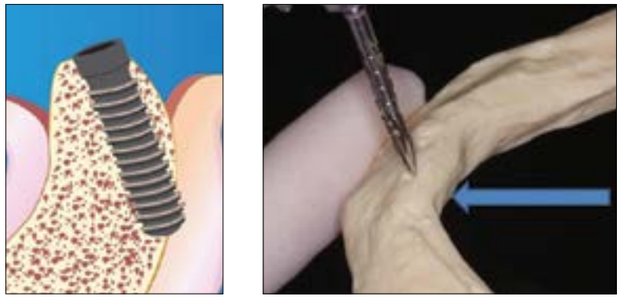

Figure 11. Incorrect positioning of the osteotomy bur results in lingual plate perforation

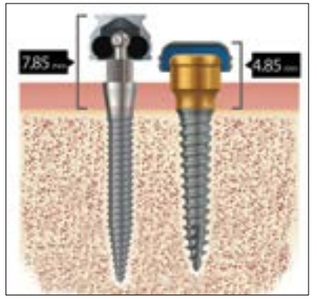

Figure 12. Height difference between O-ball and attachments with low vertical height

or interocclusal space is a challenge, the typical solution with O-ball attachments was to overcontour the denture to accommodate the bulky housing. This, however, leads to minimal tongue space and can create functional and speech difficulties. The retentive force placed on the implant can be varied chairside by selecting retentive inserts that are available from zero up to 5 pounds of force. It is recommended to use the insert with the least amount of force that will provide enough retention to have a satisfied patient. This will provide the required retention yet enable easier removal of the overdenture by the patient than would an insert with a higher retentive force.

The case studies below show the use of narrow-diameter implants with Locator attachments.

CASE STUDIES

Case 1: Flapless surgical technique for NDI placement in the mandible

A 55-year-old man presented with no lower teeth and an ill-fitting lower prosthesis (Figs. 13-14). His chief complaints were an inability to chew, pain on biting, and lack of confidence in social situations because his dentures would come out of his mouth. A comprehensive examination was performed. No signs of oral cancer were found, and all soft tissues were deemed to be healthy, with sufficient keratinized tissue present to support a new overdenture. The mandibular arch was atrophied but upon visual inspection appeared to have sufficient width and height to accommodate NDIs. A digital panoramic radiograph, clinical images and impressions for study models were taken, as well as ridge mapping measurements. Prior to the consultation appointment, the diagnostic data from the ridge mapping was used to draw in the width of available bone on the sectioned study cast. It was determined that four NDIs (2.9 mm diameter) could be placed between the mental foramena and in locations that would provide a minimum of 1 mm of bone circumferentially to encase the implant.

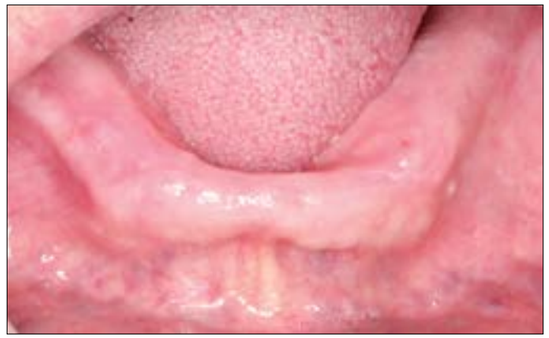
Figure 13. Edentulous mandibular arch

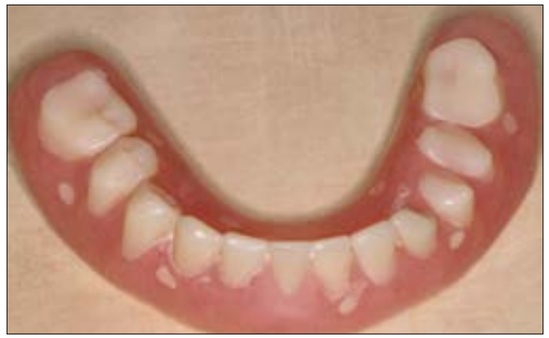
Figure 14. Poorly-designed and ill-fitting denture

Surgical Procedure

The surgical sites were anesthetized with one carpule of 2% lidocaine with 1:100,000 epinephrine. A surgical marking pencil was then used to mark the four locations for the NDIs, based on the sectioned study models. A sharp endodontic explorer was next used to create bleeding points as well as to check for proper anesthesia. A 1.2 mm pilot drill was used to create the initial osteotomy and to assess the density of the cortical plate and trabecular bone. All four surgical sites were found to have dense bone (D1), thus the 1.2 mm pilot drill was carried to full depth. The blunt end of the endodontic explorer was then used to check that there were no perforations of the buccal or lingual plates (none were found) (Fig. 15). A rotary tissue punch was used to remove a perfect circle of gingiva (Fig. 16), which allowed for visualization of the bone and proper placement of the NDI collar and prevented epithelial tissue from entering the osteotomy. A final 2.4 mm drill was used to finish the osteotomy. A parallel pin was then placed at the site and the process repeated for the three remaining sites (Fig. 17). Once all osteotomies had been created, the NDIs were removed one by one from their sterile vials and inserted into the osteotomy sites to 90% of full seating depth,

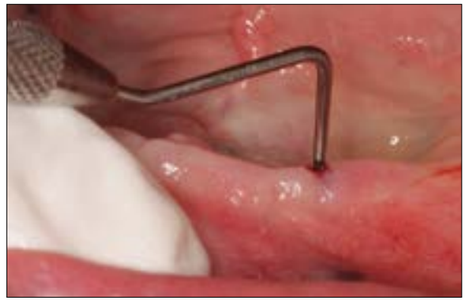
Figure 15. Using the blunt end of the endodontic explorer


Figure 16. Using the rotary tissue punch

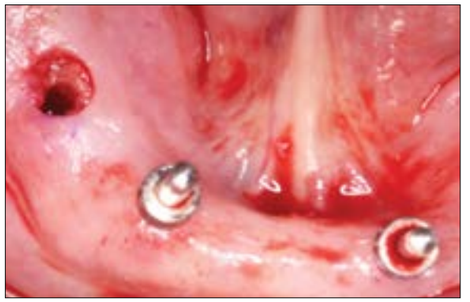
Figure 17. Visualization of bone for proper NDI placement and use of parallel pins

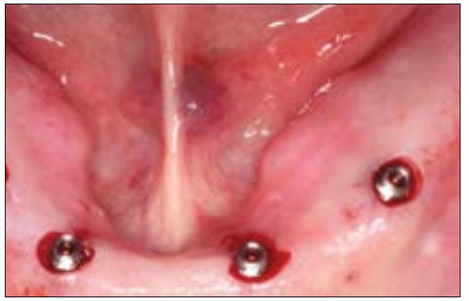
Figure 18. All NDIs in position

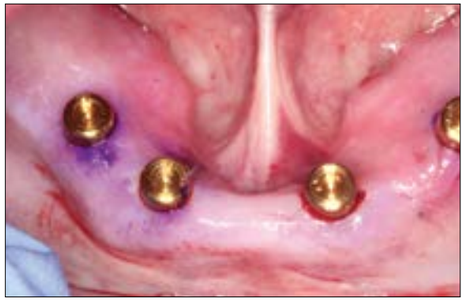
Figure 19. Attachments placed

using a handpiece driver. A torque wrench was then used applying up to 40 Ncm of torque to finish placement and primary stability was assessed (Fig. 18). The Locator attachments were then placed over the NDIs and torqued to 30 Ncm (Fig. 19). In this clinical case, because of the poor fit of the existing prosthesis, the retentive housings were not picked up chairside and instead this step was performed in the laboratory (had a well-fitting lower denture existed, the implants could have been loaded immediately). Impressions were then taken for the fabrication of a new lower overdenture, and a final panoramic radiograph was taken (Figs. 20-21).

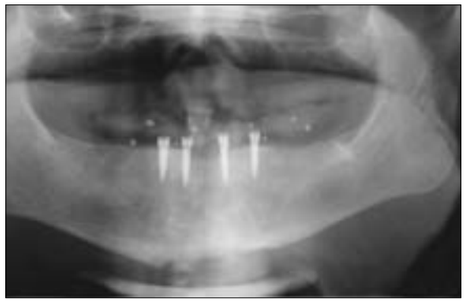
Figure 20. Final panoramic radiograph


Figure 21. Model with block-out wax around the analogs and housings incorporated into the denture

Case 2: Flapless surgical technique for NDI placement in the mandible

A 64-year-old male presented with no lower teeth. The teeth had been extracted three years earlier, and he had recently lost his lower denture at the hospital. He had an existing upper overdenture supported with six Locator attachments. His chief complaint was that before he lost his denture, he noticed that it was getting more and more difficult to eat and that his denture was less retentive than when he first had it made. His upper denture was well-fabricated, and to improve his current situation a new lower overdenture would be made. After complete diagnostic records were collected, the decision was made to obtain a cone beam CT scan because of the irregular ridge pattern. The cross sectional slices demonstrated that he would not be a good candidate for traditional-sized implants without additional surgery (Fig. 22). The anatomy of his residual lower ridge was an hourglass shape that would get thinner in the buccal-lingual dimension if the ridge was reduced. For this reason, 2.4 mm narrow-diameter implants with Locator attachments were selected. With the 2.4 mm NDIs, both the buccal and lingual plates would rigidly support the implant, avoiding the need for bone grafting or ridge splitting.

Five sites were selected in the symphysis area and were

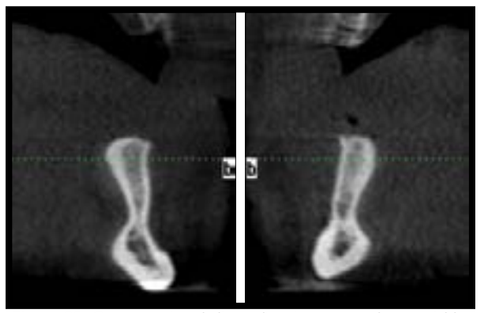
Figure 22. Cross-sectional slices showing narrow bone width

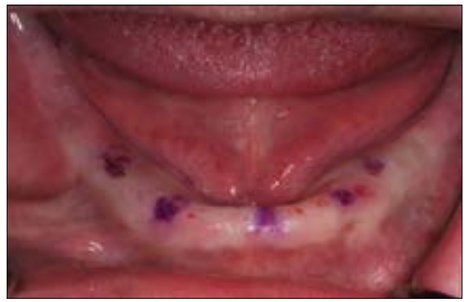
Figure 23. Implant sites marked

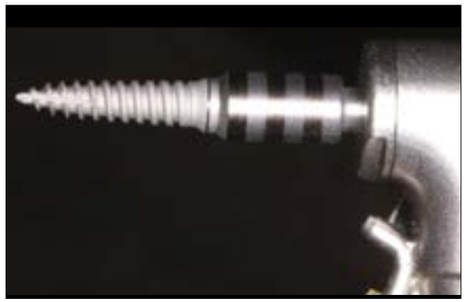
Figure 24. NDI attached to handpiece for placement

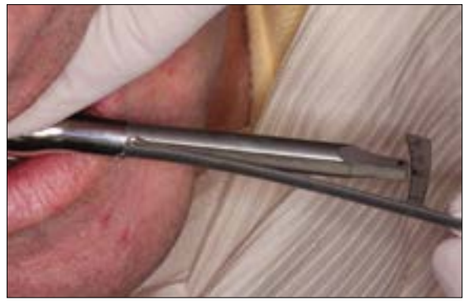
Figure 25. Torquing implant to 30 Ncm

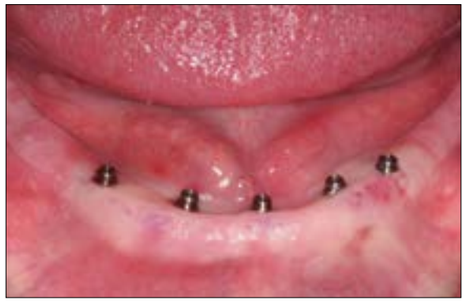
Figure 26. All five NDIs in place

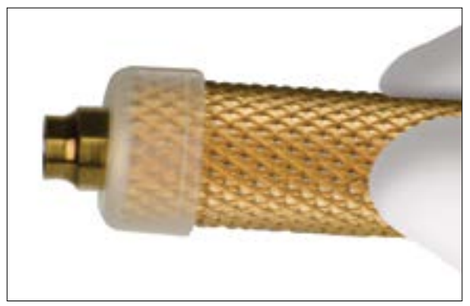
Figure 27. Attachment on driver

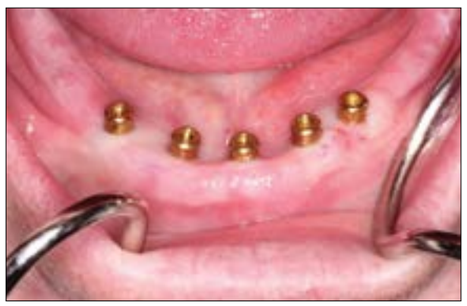
Figure 28. Attachments in position

Figure 29. Retentive males, white spacer, and housing with processing male

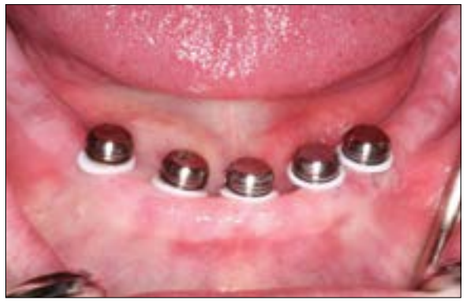

Figure 30. Housings with processing males in position, blockout spacer

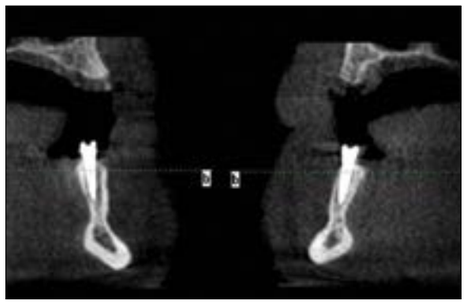

Figure 31. Post-placement CBCT images

marked with a surgical marking pencil (Fig. 23).

The necessary 1.2 mm pilot osteotomies were made and carried to full depth of the NDI selected, because of the dense nature of the bone encountered. Next, the osteotomies were prepared to full depth with the 1.6 mm drill. The implants were carried to the surgical sites and placed with the implant handpiece (Fig. 24). The implants were then fully seated with the torque wrench to ensure all threads were in bone (Figs. 25-26). One at a time, the included Locator attachments were removed from the top section of the sterile containers and hand-placed over the implant and then torqued to 30 Ncm to ensure an intimate connection (Figs. 27-28).

Over 45 Ncm of torque was obtained on the implant, thus immediate loading of the implants was possible. Along with the NDI, the packaging includes a male processing pack. The pack comes with the housing, three different retentive males, and a white block-out spacer for chairside pickup (Fig. 29). If the patient had not lost his lower denture, the Locator housings could have been placed and a retrofit with chairside pickup inside the denture could have occurred (Fig. 30). A post-implant placement cone beam CT was taken, and all five implants were found to be well-placed within the thin residual alveolar ridges (Fig. 31). The patient was thrilled with the outcome and was impressed that the NDIs were placed without making a surgical flap. He was also excited that his new lower overdenture could be started the day of implant placement and that the lower implants "felt" the same to him as his upper Locator overdenture.

Case 3: Flapless placement of NDIs for a maxillary overdenture

A 54-year-old male presented with full upper and lower dentures. His lower denture had been stabilized with O-ball mini dental implants. His chief complaint was that his upper and lower dentures were not as retentive as he would like. Clinically, the lower arch had two mini implants and would need two more implants to increase retention as the O-ball style housings do not offer the ability to increase retentive inserts. The upper arch clinically showed a broad

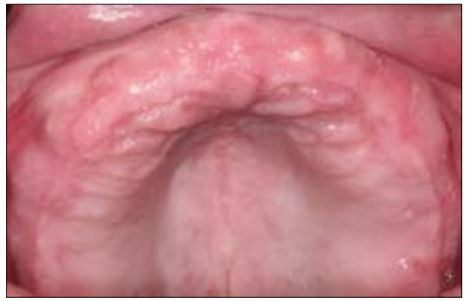

Figure 32. Pre-operative maxillary arch

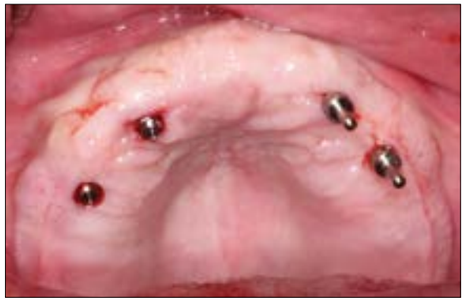

Figure 33. Two implants and parallel pins in position

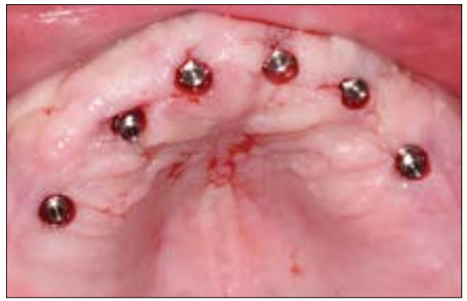

Figure 34. Additional implants placed in pairs for symmetry

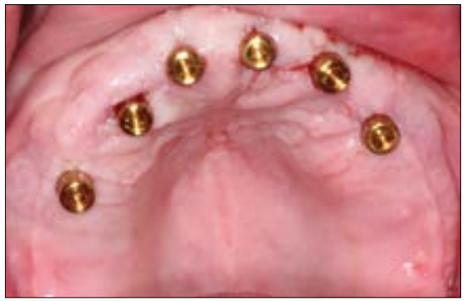

Figure 35. Attachments placed on implants

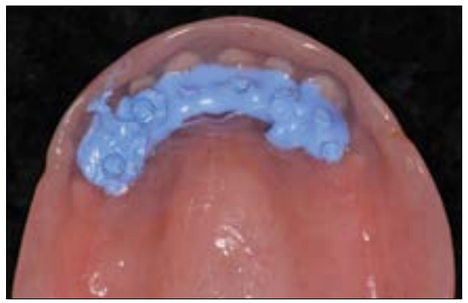

Figure 36. Checking the areas that will be relieved

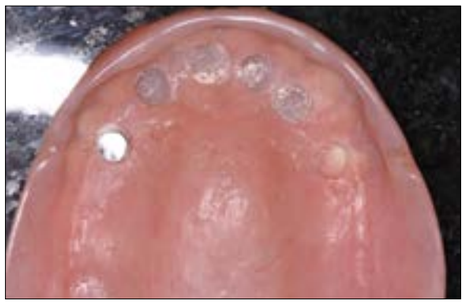

Figure 37. Post-reaming of the denture at the attachment sites

ridge, high palate vault and generally healthy mucosa (Fig. 32). In his medical history, he did disclose that he smoked around a pack of cigarettes per day. Diagnostic records were collected and a panoramic radiograph was taken. Radiographic analysis showed bilateral pneumatization of the sinuses. Because of his smoking history, sinus lifts and bone grafting were contraindicated, and it was decided to consider NDIs in the premaxilla. Ridge mapping measurements showed thick gingiva of around 4 mm and a thin ridge of around 3.7 mm in buccal-lingual width. Six sites were selected in the premaxilla, as it is recommended to have more implants in the maxilla than in the mandible in order to support an overdenture.[39] The widest A/P spread was planned for with the most posterior NDIs being placed first (Fig. 33). Additional implants were placed in pairs to ensure symmetrical distribution of load (Fig. 34). All implants placed were 2.9 mm in diameter. The implants were torqued to full depth, and more than 40 Ncm was obtained on all six implants enabling immediate loading of the implants. Guidelines for immediate loading can be found in Table 3. Locator attachments were then placed onto the implants (Fig. 35) and torqued to 30 Ncm. The block-out spacers were then placed gingivally around the implant-attachment complexes and the housings with processing males placed onto the attachments. Note that failure to use the block-out spacers would result in mixed acrylic flowing into undercuts around the attachment which would make removal of the denture impossible once the acrylic had set. The existing denture was filled in with quick-setting fit-check material to show where the denture would need to be relieved so that a passive fit could be ensured (Fig. 36). This process was repeated until no more acrylic showed through the material (Fig. 37). The relieved areas were then filled with mixed pick-up acrylic material and the denture seated over the housings until the acrylic set. The denture was then removed, any flash removed and the selected retentive males placed into the housings. A postoperative CT was taken. Although it appeared on the panoramic view that the two most posterior implants penetrated into the sinus cavity, CT slices showed that the implants were buccal to the area (Figs. 38-39).

Table 3. Guidelines for immediate loading of narrow-diameter implants in the mandible and maxilla
5 mm facial/lingual width
12 mm vertical height
Opposing a denture
Minimum of 4 implants between the mental foramena Minimum of 6 implants in the maxilla
Bi-cortical stabilization
Minimum of 10 mm of implant thread in bone
Absence of bruxism or other parafunctional habits

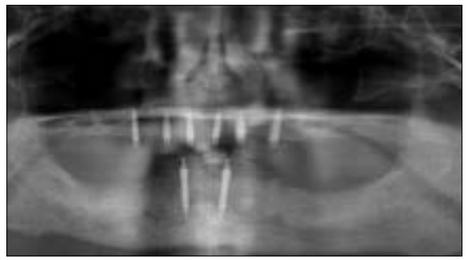

Figure 38a. Post-operative panoramic radiograph

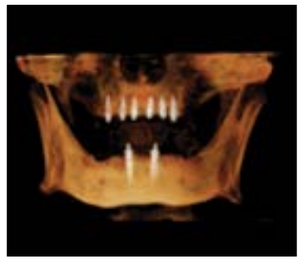

Figure 38b. Post-operative CT scan

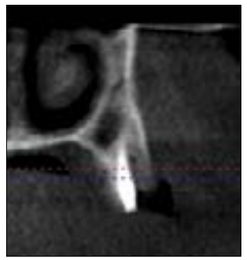

Figure 39. Post-operative CT slice showing implant buccal to the sinus

Conclusions

Narrow-diameter implants can be placed using a flapless approach and have micro and macro features that facilitate a simplified insertion protocol. Because of the NDIs' reduced diameter, cases with limited or resorbed bone can be treated with implant-retained overdentures where this would otherwise not be possible without performing procedures to augment bone. Thus, NDIs provide a minimally invasive technique for overdenture treatment that increases the retention and function of overdentures as well as patient comfort and satisfaction. NDIs are also available with self-locating attachments with low vertical height, that increase the flexibility in implant positioning and enable overdenture treatment in cases where inter-arch height is a factor, and also increase patient comfort. Implant-retained overdenture treatment improves patients' quality of life, and these newer treatment options increase the choices for patients with anatomical limitations and offer minimally invasive treatments.

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1. **Implants started to be placed for the edentulous patient during the _____.**
   a. 1940s and 1950s
   b. 1950s and 1960s
   c. 1960s and 1970s
   d. 1970s and 1980s

2. **From the 1990s until the present, a favorable treatment option for the edentulous patient has been the _____.**
   a. denture with attachments
   b. overdenture with four retained buccal roots
   c. overdenture with two standard diameter implants
   d. none of the above

3. **_____ can be a problem for some patients with traditional full dentures.**
   a. Lack of retention
   b. Denture-related pain
   c. An inability to chew
   d. all of the above

4. **Treatment of the edentulous patient with two standard body implants is _____.**
   a. well-researched
   b. uncommon
   c. only possible with bone grafting
   d. none of the above

5. **Implants can improve _____.**
   a. chewing efficiency
   b. quality of life
   c. bite force
   d. all of the above

6. **_____ implant-retained overdentures have demonstrated high success and survival rates.**
   a. Mandibular
   b. Maxillary
   c. Narrow
   d. a and b

7. **Narrow-diameter implants are _____.**
   a. root-form endosseous implants
   b. less than 3 mm in diameter
   c. a suitable alternative for patients with inadequate bone width for standard diameter implants
   d. all of the above

8. **In _____, narrow-diameter implants were cleared by the FDA for "long-term intrabony applications."**
   a. 1987
   b. 1992
   c. 1997
   d. 2002

9. **When placing an implant of around 4 mm in diameter, approximately _____ of bone width in the facial-lingual dimension is required.**
   a. 4.5 mm
   b. 5 mm
   c. 5.5 mm
   d. 6 mm

10. **The micro design of narrow-diameter implants now includes _____.**
    a. wings in the cortical portion
    b. burring
    c. a rough surface
    d. a and c

11. **Osseointegration will not occur without stability, and a minimum of _____ of torque should be achieved before considering loading the implant.**
    a. 25 Ncm
    b. 30 Ncm
    c. 35 Ncm
    d. 40 Ncm

12. **When placing implants in the mandible, amongst other areas where care must be taken, it must be taken to identify and avoid the _____.**
    a. nerve
    b. lingual artery
    c. sublingual artery
    d. all of the above

13. **Narrow-diameter implants are minimally invasive compared with alternative treatments such as _____.**
    a. bone augmentation
    b. sinus lifts
    c. dentures
    d. a and b

14. **A number of studies have together found survival rates ranging from _____ for narrow-diameter implants used for overdentures, fixed prostheses, and crowns.**
    a. 80-85%
    b. 86-91%
    c. 90-95%
    d. none of the above

15. **When using a retentive insert for an attachment with low vertical height, it is recommended to use the insert with the _____ that will provide enough retention as this will enable easier removal of the overdenture by the patient.**
    a. greatest amount of force
    b. least amount of retention force
    c. greatest diameter
    d. b and c

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CE QUIZ

16. **The occlusion for a full denture must be designed to avoid _____.**
    a. centric relation
    b. excursions
    c. movement and tilting of the dentures when the opposing arches are in contact
    d. all of the above

17. **A full denture must _____.**
    a. be planned and executed
    b. be tissue-supported on myostatic landmarks
    c. have bilateral stability when in occlusion and function
    d. all of the above

18. **A well-constructed mockup of the final denture in wax prior to implant placement can be used to define the _____.**
    a. final tooth position
    b. flange extensions
    c. implant locations
    d. all of the above

19. **_____ will provide information on bone volume and direction.**
    a. Ridge mapping, radiographs, and CT scans
    b. Radiographs, CT scans, and soft-tissue mapping
    c. CT scans, radiographs, and study models
    d. Ridge mapping, study models, and CT scans

20. **Ridge mapping is performed using _____ to penetrate the soft tissue until bone is felt.**
    a. an explorer
    b. a periodontal probe
    c. a local anesthetic needle
    d. a furcation probe

21. **Placement of four narrow-diameter implants 5 mm anterior to the mental foramena is ideal, to avoid impinging on the _____.**
    a. lingual nerve
    b. cortical bone
    c. anterior loops of the nerve
    d. all of the above

22. **One treatment option for a maxillary overdenture is to utilize six NDIs with a _____.**
    a. narrow bucco-lingual spread
    b. narrow antero-posterior spread
    c. wide antero-posterior spread
    d. wide bucco-lingual spread

23. **Caution is required when placing narrow-diameter implants in Type _____ bone.**
    a. IV
    b. III
    c. II
    d. a and b

24. **The use of as large a narrow-diameter implant as possible for the case is encouraged to _____.**
    a. minimize the width of peripheral bone
    b. maximize the implant surface area available for osseointegration
    c. maximize the potential for bicortical stabilization
    d. b and c

25. **Myostatic principles are used to identify the areas in the edentulous mouth that _____ when swallowing, opening, closing, or speaking.**
    a. will move
    b. will not move
    c. will adjust
    d. none of the above

26. **Patients who would benefit from implants may not do so due to _____.**
    a. inadequate bone
    b. financial or time constraints
    c. compromised physical conditions
    d. all of the above

27. **Using attachments with low vertical height when interocclusal space or vertical height is a challenge, rather than an O-ball attachment, _____.**
    a. removes the need to overcontour the denture
    b. reduces the possibility of speech difficulties
    c. preserves tongue space
    d. all of the above

28. **Results have demonstrated _____ with NDI-retained overdentures.**
    a. stability
    b. retention
    c. patient comfort
    d. all of the above

29. **Locator attachments with low vertical height allow for a total divergence between two implants of up to _____.**
    a. 15 degrees
    b. 30 degrees
    c. 40 degrees
    d. none of the above

30. **Newer treatment options for overdentures with narrow-diameter implants_____.**
    a. increase options where anatomical limitations exist
    b. offer minimally invasive treatments
    c. should be delayed
    d. a and b

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EDUCATIONAL OBJECTIVES

1. List and describe considerations in overdenture treatment utilizing implants
2. Describe the concept behind myostatic denture design and how this can be achieved
3. Review the treatment planning for narrow-diameter implants
4. Review and describe the use of attachments with low vertical height

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2. Usefulness of content ..... ③ ② ①
3. Benefit to your clinical practice ..... ③ ② ①
4. Usefulness of the references ..... ③ ② ①
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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? _____

_____

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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TURN PAGE

The Selection, Use and Accuracy of

Alginate Impression Materials

ABSTRACT

Elastic impression materials include alginate, as well as the silicone and polyether materials that offer high levels of precision and detail. Recently, next-generation alginates and alginate substitutes have become available. These retain the advantages of traditional alginates and avoid some of their disadvantages. Alginates are the most-used impression material in the dental office, and while they seem basic, achieving good alginate impressions, whether with standard or next-generation materials, requires attention and a standardized technique involving good tray selection, mixing of the alginate, impression taking and pouring of the stone or plaster model.

EDUCATIONAL OBJECTIVES

The overall goal of this article is to provide the reader with information on impression materials, and specifically the use of impression materials for study models and appliance fabrication. Upon completing this article, the reader will be able to do the following:

1. List the categories of impression materials
2. List and describe the advantages and disadvantages of available types of impression materials
3. Describe the considerations when selecting a tray for alginate impressions
4. Delineate the difference between hand and mechanical mixing of alginates and results obtained
5. Review the clinical and laboratory processes by which alginate impressions are taken and poured.

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TURN PAGE

Introduction

A number of impression materials are available for use in the dental office. A primary consideration in determining which material is appropriate is the intended use of the impression. For all impression materials, desirable properties include accuracy, dimensional stability, a pleasing smell and taste, the shortest setting time that is suitable for a given procedure, and easy removal of the set impression.[1] With elastomeric impression materials being the most popular, they fall into two categories: aqueous hydrocolloids (alginates and agars) and non-aqueous rubber (polysulfides, silicones, and polyethers) materials (Figure 1).

Non-aqueous Elastomeric Impression Materials

Non-aqueous elastomeric impression materials include polysulfide, polyether, condensation silicone, and addition silicone (vinyl polysiloxane). These are high-precision and essential for impressions that will be used for the fabrication of indirect restorations and laboratory-fabricated aligners. Since these materials do not absorb or lose water (with the exception of polyether material), they are dimensionally stable and allow for delayed pouring of stone. They are, however, more expensive to use. Labs prefer these due to their long-term stability.

Vinyl polysiloxane (VPS) and polyether (PE) materials are available in faster and slower setting variants, light- to heavy-body viscosities, and can be used in either a full or partial tray (Table 1) depending on the clinical case and preference. Requirements for non-aqueous elastomeric materials include an adequate working time; a range of suitable viscosities (thin, medium, thick and putty); a set hardness that is compatible with the tray type used (the strain-in-compression property of the material); highly precise replication of details (preparations, margins and adjacent soft tissue); elastic recovery; excellent tear strength; and stability of the set impression until a model can be produced. These materials offer a long deformation-free window prior to model pouring, and allow multiple pours if necessary. All of these properties are necessary for accurate replication.

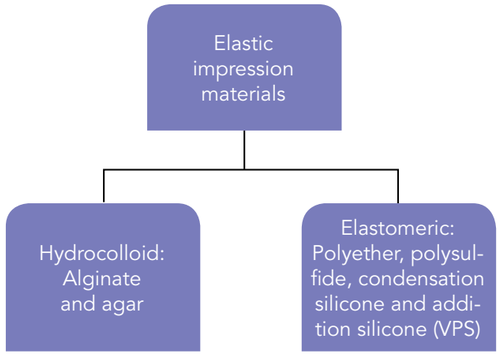

Figure 1. Elastic impression materials.

PE impressions are taken using a one-stage technique. VPS, which is an addition silicone, can be used in either a one-stage or two-stage technique (where two layers of different viscosities are used for the impression). It should be noted that VPS materials should not be poured immediately, as they require at least one hour to "de-gas" hydrogen and avoid porosities in the resulting model.

There are some disadvantages to using these impression materials for full-arch impressions that will be made on unprepped teeth and used for models for fabricating sports mouthguards or custom trays. Due to the expense, relatively long setting time, and the amount of material needed for full-arch impressions, this family of impression materials is not generally recommended when creating models for in-office use. The set silicone can be a challenge to remove from the mouth, which can be uncomfortable for the patient. Equally challenging is removing the set model without breakage.

Aqueous Elastic Impression Materials

Agar and alginate are both aqueous elastic impression materials. Agar is a highly precise reversible hydrocolloid that has many uses in fixed and removable prosthodontics. It has been in use since Sears created it in 1937 and consists of 85% water and 15% agar.[2] However, this material is difficult to handle and requires use of a heating device to render a viscosity suitable for impression taking. A water-cooled tray must be used while taking the impression, after which the agar reverts to a solid state upon cooling. A further issue is that it is generally recommended to pour reversible hydrocolloid impressions immediately due to dimensional instability. Reversible hydrocolloids are now less frequently used in the United States for impressions.

Alginate Impression Materials

Alginate was originally developed by the US Navy as a replacement for agar during World War II, when agar became unavailable. It is the most frequently used impression material, used for study models as well as models for the fabrication of appliances, bleaching trays, and indirect provisional restorations.[3,4] Alginates consist of a powder containing sodium alginate or potassium alginate, calcium sulphate, trisodium phosphate, filler (diatomaceous earth), zinc oxide, and potassium sulphate, plus flavoring and coloring agents; this powder is mixed with water. The sodium alginate and calcium sulphate react chemically to produce sodium sulphate and calcium alginate, and the trisodium phosphate is added to retard the setting reaction and give sufficient working time for the impression.[5]

Stage 1: Retardation of the setting reaction

$$2Na_3PO_4 + 3CaSO_4 \longrightarrow Ca_3(PO_4)_2 + 3Na_2SO_4$$

Stage 2: Setting reaction of the alginate

Na alginate + $CaSO_4$ — mixed with water ⟶
Ca alginate + Na_2SO_4

Advantages of alginates include their ease of use, hydrophilicity and therefore tolerance of the presence of moisture, low cost, and ability to be used in stock trays. They are suitable for full-arch impressions and easy to remove from undercuts and unprepped teeth. Traditional disadvantages, however, have included a low tear strength, porosities in the surface of the poured models, a low level of detail (although usually adequate for the intended purpose) and generally poor results if the impression is reused after the pouring of one model.[6] In one laboratory study, however, it was found that if impressions were stored properly, a second pour was possible if this occurred within 45 minutes of the impression being taken.[7] Poor dimensional stability may also be a disadvantage, particularly if set alginate impressions are improperly stored (rapidly drying out if left out after setting and the potential for absorption of liquids). One recent bench study found that provided they were properly stored, models

Table 1. Characteristics of elastomeric impression materials
High precision
Excellent capture of details of preparations and adjacent soft tissue
Good elastic recovery
Good dimensional stability
Enable multiple pours
Available in different viscosities
Relatively long setting times
Available with various setting times (material dependent)

Table 2. Characteristics of traditional alginate materials
Easy to use
Moisture tolerant
Lower level of detail – sufficient for study models, and models for appliances
Require careful storage to prevent shrinkage or liquid sorption after setting
Easy-to-remove set impression from undercuts and unprepped teeth
Low tear strength
Single pour only
Available with various setting times (varies with amount of retarder)
Low cost

poured from 5-day-old alginate impressions were still accurate for diagnosis and fabrication of appliances.[8] It is generally recommended to either pour alginate impression materials immediately or store them in a damp towel for a short period of time while transporting them to the laboratory[9] (Table 2).

Recent developments

Newer impression materials have been introduced to address the shortcomings of traditional alginate materials, while retaining their advantages as well as achieving some of the advantages of non-aqueous elastomeric impression materials. Recent additions include vinyl polysiloxane "alginate substitute" materials that are mixed with an automix tip, are dimensionally stable, and allow for multiple pours. Compared to alginate impression material, these alginate substitutes have been proven to have greater tear strength, greater detail reproduction, and less outgassing and model porosity. At the same time, these are faster setting than traditional VPS and less expensive.[10]

A further development has been the introduction of a next-generation alginate impression material that is heavy-bodied to help move the peripheral tissues out of the way and capture the anatomy of the dental arch in question without slumping. Compared to typical alginates, it claims to offer improved dimensional stability (2 or 5 days of dimensional stability), a reduced setting time (45 or 60 seconds), easier removal after setting, and the ability to double pour models. A second (or double) pour is routinely performed when fabricating models for aligners. The model from the second pour is useful to track the orthodontic movement from the clear aligners throughout treatment, as well as providing a backup model in the event the patient loses an aligner.

Keys to Successful Alginate Impressions

Dental assistants need to be the métiers of impression taking and model pouring to ensure well-fitting appliances. However, there are several alginate impression techniques being used in any office, depending on the number of people who take them. There are basically six keys to success in obtaining an impression that will produce an accurate model, as shown in Table 3.

Tray Selection

The most common full-arch impression trays are plastic and stainless steel rim-lock trays (Figure 2). Disposable Styrofoam™ trays are traditionally used by orthodontic offices when impressions are sent to a lab for archival model fabrication. Because of their design, these trays are able to record the vestibule. Some of the disadvantages of Styrofoam™ trays include: 1) An alginate adhesive should be applied prior to use; 2) they can be expensive; 3) because they are more size-specific, a larger inventory will be required which could also cause storage challenges; and 4) when a heavy-bodied alginate is used, these trays may crack. Stainless steel rim-lock trays are still regarded as the gold standard in dentistry. The extensive number of perforations in the tray, combined with the rim-lock design, offers great anchorage for a heavy-bodied alginate, with no adhesive required. Plastic trays are available in two basic designs. Those with small round holes are designed for silicone impression materials and are very useful in crown and bridge procedures. However, they prove untrustworthy when heavy-bodied alginate is used, because the holes are too small for the material to extrude properly (Figure 3). When the impression is removed from the mouth, there can be a pull-away of the alginate from the tray, which will create distortion if it goes unnoticed. Plastic trays that have slots are ideal for heavy-bodied alginate. The slots allow for extrusion of the viscous material, which offers excellent retention (Figure 4). In fact, one study found stock plastic trays resulted in less linear discrepancy of alginate impressions than did stock metal trays.[11]

Table 3. Keys to successful alginate impressions
Tray selection
Choosing the appropriate material
Proper mixing of the material
Tray insertion and position in the mouth
Handling of impression prior to pouring the model
Selection and mixing of the gypsum product

Besides the material the impression tray is made of, size matters. The proper size tray will provide enough space for the impression material and enough room for the alginate to record an imprint of the arch without allowing any show-through of the tray. The trays should be long enough to capture the hamular notches and the retromolar pads without impinging on the ramus of the mandible or the pharyngeal folds (Figure 5).[12] When the proper match between tray and material is obtained, adhesive is not required.

The tensile bond strength between the tray and impression material determines whether or not the impression separates from the tray during removal from the patient's mouth. If the use of adhesive is a personal preference, research has shown an increase in tensile bond strength and therefore a reduction in separation of the material from the trays.[13]

Proper Mixing of Alginate

Hand mixing of alginate impression materials has been the accepted technique since its introduction. However, hand mixing relies on the accuracy of the person measuring out the powder and water and mixing the alginate, as well as thorough mixing for the correct length of time. Recent research has shown a positive improvement in the quality of the mix when mechanical means are used, as well as improvements in the elastic recovery and compressive strength of the resulting alginate impressions, which in turn improve the accuracy of the impression material.[14,15] Almost no porosities were found in alginate that was mixed with an automatic alginate mixer, and the researchers concluded that the standardization of the mix was preferred over traditional hand mixing.[14,16]

Options available for mechanical mixing of alginates include an automated vacuum mixer, an automated centrifugal-spinning mixer, and a semi-automated mixer that requires hand mixing of alginate in an automatically rotating bowl. It was reported in one study that the centrifugal mixer and vacuum mixer resulted in significantly fewer porosities than the semi-automated mixer.[17] Mechanical mixers could also be considered "equalizers" for full-time or experienced staff members in comparison to part-time or inexperienced staff members. Mechanical mixing enables any staff member (or dental professional) to make a perfect mix every time and also reduces the need for cleanup. After mechanical mixing, the impression tray that has been preselected for the best fit is loaded with the impression material and inserted into the patient's mouth.

Considerations in selecting a mechanical mixer include the degree of automation, ease of use and mixing protocol, reliability of mixing and results, portability of the device (whether it can be moved easily from one operatory to another), cost of the mixing equipment, any installation requirements (e.g., a vacuum line for vacuum mixers, and for which an existing office without a vacuum line would need to be retrofitted), and the ease of cleanup after mixing of the alginate. From a clinical standpoint, when these authors introduced mechanical mixing into their office about 6 years ago, the improvement in the impressions was immediately noticed. The resulting models provided better overall fit in the appliances made from them and decreased the number of remakes of appliances tremendously. The use of a mechanical auto mixer (TurboMAX®) is shown on the following page. Mixing is standardized and uses distilled water, which has fewer impurities than tap water. The amounts of powder and water are measured into the mixing cup, and the lid is closed and then locks while mixing occurs under centrifugal force (Figures 6-8).

Figure 2. Stainless steel rim-lock, plastic perforated and Styrofoam trays

Tray Positioning

Proper tray positioning ensures a greater chance of success. The causes of error that may appear at this stage in the protocol include: 1) Incorrect tray size; 2) improper tray positioning; and/or 3) poor capture of the vestibular area. Examining the resulting impression to ensure there is no show-through of the tray in the impression is critical to the success of the model and the appliance. In this picture, there is both show-through from an improperly seated impression as well as an air void where the anterior vestibule should be (Figure 9).

On tray insertion, results are more predictable when the assistant stands behind the patient for upper impressions, and in front of the patient for lower impressions. This allows for an easier approach of the free hand, allowing the assistant to retract the lip away from the teeth during tray insertion. With this method, the alginate material will not be blocked out of this important area, and all of the vestibular area can be captured. Another method is to first insert cheek retractors (Figure 10). This gives the assistant the best view of all vestibules. When the tray is inserted, it becomes very easy to position it properly. The tray flanges push up or down on the retractors and provides all the space needed for a perfect impression (Figures 11-12). When inserting a lower tray, it is also helpful to ask the patient to lift his or her tongue toward the palate and then bring the tongue back into position—this enables placement of the tray to capture all soft-tissue contours lingually.

Mixing Stone for Models

There are a variety of gypsum products available for fabricating models. If appliances such as removable partial dentures, orthodontic retainers or clear aligners are being fabricated, die stone is preferable because it provides excellent detail and hardness. Die stone can be purchased in unidose packets, which offer convenience but can also be expensive. Stone purchased in bulk is more economical, but its use has the reputation for inattentive measuring by users (e.g., evidenced by the use of a plastic cup and a trickle of water from the faucet until it seems to be the correct viscosity). The success of the study model (or appliance) depends on a rigid, although easy, protocol that includes following the manufacturer's powder/liquid ratio instructions. A convenient and inexpensive way to ensure that the correct amount of powder is being used is to premeasure the powder and place single premeasured doses in plastic containers that are always ready to use when an impression is being poured up (Figures 13-14).

Having two different-sized containers can be very helpful, so that a single or double premeasured dose is available depending on whether one or two impressions are being poured. A larger container can hold 150 g of powder, which will pour two impressions, while a smaller container can hold 100 g of powder, which will pour one impression. The proper protocol for impression pouring requires the assistant to rinse the impression under a powerful water stream. The excess water is shaken from the impression and debubbler is sprayed into the impression prior to the pour. The impression is set aside while the assistant measures the water into the flexibowl that contains

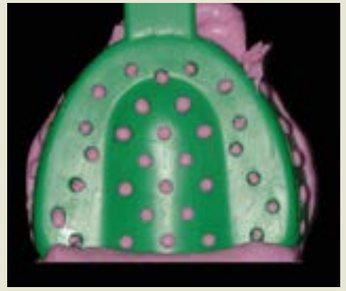
Figure 3. Plastic tray with small round holes provides poor alginate retention.

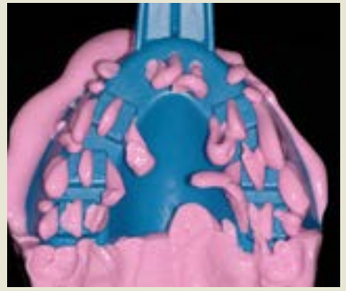
Figure 4. Plastic tray with slots, enabling extrusion of the material for retention and excellent results

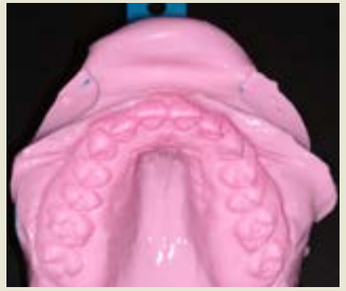
Figure 5. Capture of all anatomical details


Figure 6. Mixing cup with measured powder and water


Figure 7. Mixing cup in the mechanical mixer, closing the lid


Figure 8. Resulting homogenous mix

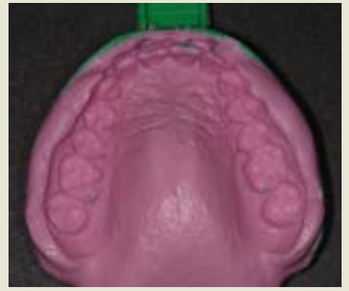
Figure 9. Improperly seated impression with show-through of the tray and an air void

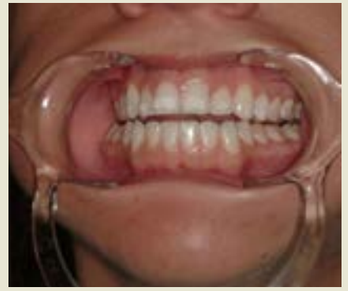
Figure 10. Insertion of cheek retractors

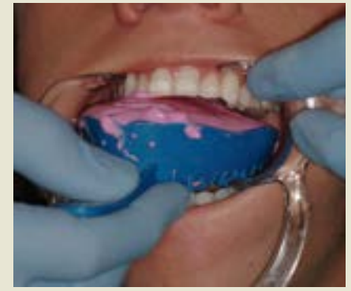
Figure 11. Ease of insertion with cheek retractors

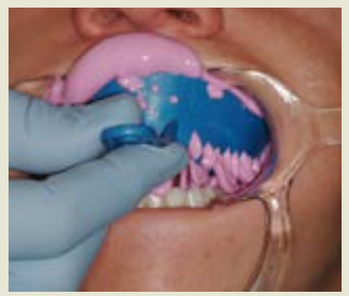
Figure 12. Impression tray seated


Figure 13. Pre-measuring stone powder for single doses


Figure 14. Single-dose containers with stone powder

the premeasured die stone. The die stone and water are then spatulated to a creamy mixture. A vibrator is then used to pour the stone into the impression, and the stone is left to set. The resulting models can generally be separated in about 30 minutes and are ready for use. Once the stone model has set, it should be removed within 1 hour from the alginate, as failure to do so can result in imperfections on the stone model.[18]

Conclusions

Following proper protocol in any dental procedure increases the potential for a successful outcome. Certainly when fabricating appliances, every step counts. Even one misstep during the process can result in an appliance that does not fit. In turn, this is discovered when the non-fitting aligner or appliance is tried-in at the delivery appointment, costing time and money and eroding patient confidence. With the selection of the appropriate impression material and impression technique, impression taking is reliable and reproducible, with consistent successful results.

Glossary of Terms

Compressive strength: *The ability of a material to resist compressive stress without fracturing*
Elastomeric: *A polymer that has elastic properties*
Elastic recovery: *The ability of a material to rebound to its original shape after being deformed*
Hydrophilicity: *The affinity of a material for water*
Outgassing: *The release of embedded gas (or occluded gas) from a material*
Tear strength: *The ability of a material to resist tearing*
Tensile bond strength: *The ability of a material to resist being separated from material (i.e., being debonded)*

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CE Quiz

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1. The _____ is a primary consideration in determining which impression material is appropriate.
a. expense
b. intended use of the impression
c. atmosphere
d. all of the above

2. _____ is a desirable property for an impression material.
a. A pleasing smell and taste
b. The shortest setting time suitable for a given procedure
c. Easy removal of the set impression
d. all of the above

3. _____ is an elastic impression material.
a. Plaster of Paris
b. Wax
c. Compound
d. none of the above

4. Elastic impression materials are _____.
a. all aqueous
b. all non-aqueous
c. inaccurate
d. none of the above

5. Addition silicone is an example of _____ impression material.
a. an elastomeric
b. a reversible hydrocolloid
c. a non-aqueous
d. a and c

6. _____ is used as a material for high-precision impressions for indirect restorations.
a. Compound
b. Vinyl polysiloxane
c. Alginate
d. all of the above

7. Addition silicone (VPS) impression materials _____.
a. are dimensionally stable after setting
b. do not imbibe water
c. allow for multiple model pours
d. all of the above

8. The set hardness of an impression material should be compatible with _____.
a. saliva
b. the tray that will be used
c. the particular gypsum that will be used
d. none of the above

9. Vinyl polysiloxane _____.
a. can be used with a one-stage or a two-stage technique
b. is relatively low-precision
c. is a polyether
d. a and c

10. The details of the _____ can be captured using a highly precise impression material.
a. soft tissue adjacent to preparations
b. margins
c. preparations
d. all of the above

11. A set impression should remain stable until the _____.
a. patient goes home
b. impression reaches the laboratory
c. models and dies, as appropriate, are poured
d. none of the above

12. It can be difficult to remove a full-arch impression of unprepped teeth taken with _____.
a. agar
b. alginate
c. vinyl polysiloxane
d. all of the above

13. Agar as an impression material _____.
a. is a highly precise reversible hydrocolloid
b. can be used for crown and bridge impressions as well as models
c. has been in use since 1937
d. all of the above

14. A water-cooled tray must be used when taking _____ impression.
a. an alginate
b. an agar
c. a silicone
d. none of the above

15. _____ is the most frequently used impression material.
a. Polyether
b. Silicone
c. Alginate
d. none of the above

16. Trisodium phosphate is added to alginate power to _____.
a. accelerate the setting reaction
b. improve the viscosity of the material
c. retard the setting reaction
d. b and c

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CE QUIZ

17. Alginates consist of a powder in which one of the ingredients is _____.
a. potassium alginate
b. sodium alginate
c. calcium alginate
d. a or b

18. If a set alginate impression is left out on the bench after the impression has been taken, _____.
a. it may shrink
b. this will increase the tear strength
c. this will increase the surface hardness for pouring the stone model
d. b and c

19. "Alginate substitute" materials that have been introduced _____.
a. are vinyl polysiloxanes
b. are dimensionally stable
c. allow for multiple pours
d. all of the above

20. A next-generation alginate impression material is available, and _____.
a. is heavy-bodied to help move the peripheral tissues out of the way
b. captures the anatomy of the dental arch without slumping
c. allows for a double pour
d. all of the above

21. _____ is key to successful alginate impressions.
a. Choosing the appropriate tray and material
b. Proper mixing and handling of the material during and after impression taking
c. Proper tray insertion and positioning in the mouth
d. all of the above

22. _____ are the most common full-arch impression trays.
a. Styrofoam and stainless steel rim-lock trays
b. Plastic and stainless steel rim-lock trays
c. Styrofoam and plastic
d. none of the above

23. Plastic trays that have slots are ideal for _____, and the material can extrude through the slots.
a. putty thickness impression material
b. moderate-viscosity alginate
c. heavy-bodied alginate
d. none of the above

24. A positive improvement in the quality of an alginate mix has been found when _____.
a. extra water is added
b. less water is added
c. mechanical mixing is used
d. b and c

25. _____ is an option for a mechanical mixer for alginate.
a. A semi-automated mixer
b. An automated centrifugal-spinning mixer
c. An automated vacuum mixer
d. all of the above

26. _____ can lead to impression errors, which will result in inadequate models.
a. Incorrect tray size
b. Improper tray positioning
c. Poor capture of the vestibular area
d. all of the above

27. On tray insertion, results are more predictable when the assistant stands in front of the patient for _____.
a. upper impressions
b. lower impressions
c. double impressions
d. a and b

28. First inserting cheek retractors before taking an impression gives the assistant the _____.
a. least chance that the patient will gag
b. least chance that the patient will vomit
c. best view of all vestibules
d. all of the above

29. Die stone is preferable when the model will be used for _____ because it provides excellent detail and hardness.
a. clear aligners
b. orthodontic retainers
c. removable partial dentures
d. all of the above

30. With the selection of the appropriate impression material and impression technique, impression taking becomes _____.
a. reliable
b. reproducible
c. consistently successful
d. all of the above

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EDUCATIONAL OBJECTIVES

- List the categories of impression materials
- List and describe the advantages and disadvantages of available types of impression materials
- Describe the considerations when selecting a tray for alginate impressions
- Delineate the difference between hand and mechanical mixing of alginates and results obtained
- Review the clinical and laboratory processes by which alginate impressions are taken and poured

COURSE EVALUATION

Please evaluate this course using a scale of 3 to 1, where 3 is excellent and 1 is poor.

1. Clarity of objectives ..... ③ ② ①
2. Usefulness of content ..... ③ ② ①
3. Benefit to your clinical practice ..... ③ ② ①
4. Usefulness of the references ..... ③ ② ①
5. Quality of written presentation ..... ③ ② ①
6. Quality of illustrations ..... ③ ② ①
7. Clarity of quiz questions ..... ③ ② ①
8. Relevance of quiz questions ..... ③ ② ①
9. Rate your overall satisfaction with this course ..... ③ ② ①
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? _____

_____

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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Caries Risk Assessment:
Treatment Planning and Prevention

ABSTRACT

Dental caries continues to be a major health problem in the United States. Caries disease is a multifactorial process that requires more than surgical restoration. Current science focuses on addressing caries by integrating individualized caries management by risk assessment (CAMBRA) strategies, and implementing corrective treatments created for each individual patient. Caries prevention and treatment is an attainable goal and a simplified approach is needed to initiate the change processes.

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EDUCATIONAL OBJECTIVES

The overall goal of this course is to provide the reader with information on dental caries, prevention, and management. On completion of this course, participants will be able to:

1. Describe the caries disease process
2. Discuss the implementation of CAMBRA into clinical practice
3. Define caries risk levels; and
4. Review the evidence-based recommendations for patients with different caries risk levels.

Although the prevalence of caries has been declining, dental caries remains a major health problem in the United States, especially in certain populations.[1] For example, a 1997 study reviewing isolated areas in Arizona found high caries risk levels in low-income populations[2] and more recently, a study published in 2012 reported the high caries risk levels in American Indian and Alaskan native populations.[3]

With more innovative education and an understanding of caries risk assessment, progress has been made that helps in the caries prevention process.[4,5] There has been much effort in defining and identifying the caries disease process and risk factors that contribute toward the expression of this disease (caries lesions).

Dental caries is initiated by a complex acid-producing biofilm and its chemical interactions with the tooth surface.

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The bacterial make-up of biofilm and its ability to create acid changes dynamically, depending on the location of the biofilm on the tooth, pH, and the chemistry of the surrounding local environment. The lower the pH, the greater the potential that biofilm organisms will produce acid.[6] As a result of this acid production, a demineralization process occurs and cavitation of the tooth surface may develop if a preventative plan is not introduced. Interestingly, given enough time, even commensal bacteria can adapt to survive in a low pH environment and create acid.[7,8] Considerations in the integration of caries interventions to eliminate pathogenic organisms include introducing antibacterial agents and employing strategies to raise the pH intraorally. At a higher pH range, acidogenic organisms cannot thrive.[7]

Introducing caries management by risk assessment (CAMBRA) into clinical practice is a way to focus on changing deleterious biofilm behavior, by decreasing the pathogenic risk factors that cause demineralization and implementing a chemical reversal of the process (remineralization). Correcting the process early can reverse and arrest early caries lesions before cavitation occurs, and prevents the formation of new lesions. Integration of this methodology can be simplified by a logical flow of data collection with caries risk assessment, establishing a diagnosis and prognosis, and then recommending prevention and treatment interventions as well as providing patient education.

Data Collection and Caries Risk Assessment

The information and the manner in which data is collected varies among practitioners. There are many ways to do these steps and the examples given are not intended to imply that there is only one correct way to do CAMBRA. Clinicians must adapt to a method that is comfortable for them and consider current science as a means to direct their vision of implementing CAMBRA in their practice settings. Data collection starts with a comprehensive clinical examination which gathers valuable information needed to perform the caries risk assessment.

Clinical Examination

The hard tissue examination involves the very earliest detection possible of non-cavitated caries lesions so that decisions regarding interventions may be made. Having a lesion classification system that measures the site, extent, and if possible the activity of the lesion at all stages of lesion progression (from early demineralization to cavitation) is essential in properly treating this disease. One suggested way to chart all stages of caries lesions was published by Young and Featherstone in 2013 and will be summarized here briefly.[9] The clinical examination also includes an assessment of the biofilm and saliva; many clinicians choose to include additional testing which will be discussed in more detail later.

Hard Tissue Exam and Charting by Location, Severity and Activity

Occlusal: These surfaces can be charted using the International Caries Detection and Assessment System (ICDAS) codes, noting deep pits or fissures and lesion activity when possible (Table 1). Compare the picture and definition to what you see clinically and note the code.[10] This allows for tracking of the lesion's progression over time, thereby helping to decide if surgical intervention is appropriate. More information on this system and a more detailed description of the codes used can be found at *www.icdas.org*.

Approximal: The depth of the radiolucencies are noted approximally on bitewing radiographs as E1 (outer ½ of enamel); E2 (inner ½ of enamel); D1 (outer 1/3 of dentin); D2 (middle 1/3 of dentin); or D3 (inner 1/3 of dentin). The progression or regression from previous and future radiographs should be noted, when possible (Table 1).

Elastomeric tooth separation (using an orthodontic separator) is a technique that can be used to confirm surface cavitation visually on proximal surfaces.

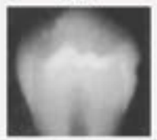
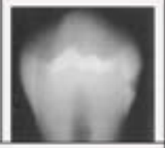
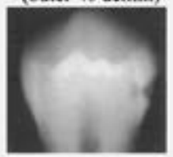
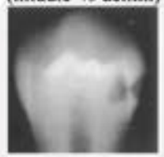
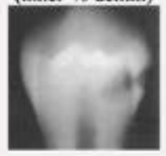
Facial/Lingual: A careful visual and tactile examination should be performed using the round end of an explorer or a ball-ended probe, noting the following: Active white/brown spots (dull, rough surface); inactive white/brown spots (smooth, shiny and hard); cavitations that are still visibly in enamel; and cavitations that visibly extend into dentin (Table 1).

Table 1. Site specific, risk-based management

Occlusal Site and Extent

ICDAS code 0	ICDAS code 1	ICDAS code 2	ICDAS code 3	ICDAS code 4	ICDAS code 5	ICDAS code 6
						
Management **Low Risk:** Sealants not indicated for inactive lesions; continue nonsurgical preventive maintenance; however sealants may be considered optional for primary prevention of at risk (deep) pits and fissures. **Moderate Risk:** Sealants recommended ***High or ** Extreme Risk:** Sealants recommended			**Management** **All Risk Levels:** Minimal removal of tooth structure to ensure adequate seal for dental material used.			**Management** **All Risk Levels:** Conservative caries removal when near the pulp; ensure adequate seal for dental material used.

Approximal Site and Extent

Radiographic E0 ***	Radiographic E1	Radiographic D1 (outer 1/3 dentin)	Radiographic D2 (middle 1/3 dentin)	Radiographic D3 (inner 1/3 dentin)
				
Management Chemical treatment or preventive maintenance.	**Management** Chemical or preventive therapy. Demonstration of lesion progression or regression and/or elastomeric tooth separation preferred before surgical intervention is considered.	**Management** Minimally invasive restoration probable (but not absolute) based on lesion progression, regression, or tooth separation.	**Management** Minimally invasive restoration needed. Conservative caries removal when near the pulp; ensure adequate seal for material used.	

Facial/Lingual Site and Extent

Non-cavitated Inactive	Non-cavitated Active	Partially cavitated	Fully cavitated	Fully cavitated
				
(shiny, smooth)	(matt, rough)			
Management Active white or brown spot lesions receive chemical therapies based on caries risk assessment (CRA).		**Management** May receive nonsurgical chemical therapy or minimally invasive restoration depending on clinician and patient discussion of treatment options.	**Management** Minimally invasive restoration	**Management** Conservative caries removal when near the pulp; ensure adequate seal for material used.

* Patients with one (or more) cavitated lesion(s) are high risk patients. ** Patients with one (or more) cavitated lesion(s) and/or hyposalivation are extreme risk patients
All sealants and restorations to be done with a minimally invasive philosophy in mind. Sealants are defined as confined to enamel. Restoration is defined as in dentin. A 2 surface restoration is defined as a preparation that has one part of the preparation in dentin and the preparation extends to a second surface (Note: the second surface does not have to be in dentin). A sealant can be either resin-based or glass ionomer. Glass ionomer should be considered where the enamel is immature, or where fissure preparation is not desired, or where rubber dam isolation is not practical. Patients should be given a choice in sealant placement and material selection. ***Notations system used here: on bitewing radiographs as E1 (outer 1/2 of enamel), E2 (inner 1/2 of enamel), D1 (outer 1/3 of dentin), D2 (middle 1/3 of dentin),
or D3 (inner 1/3 of dentin) and note the progression/regression from previous radiographs if possible.

Lesion Activity Assessment*
(Parameters in black indicate activity; italicized, no activity)

Initial caries risk status – High, Moderate, *or Low*	Location of the lesion – Plaque stagnation area, natural, *or not*
Visual appearance – Cavitation/shadow, whitish, *or Brownish*	Tactile feeling — Rough enamel/soft dentin, *or smooth enamel/hard dentin*
Gingival status (if the lesion is located near the gingiva) – Inflammation, Bleeding, on Probing, *or no Inflammation, no bleeding on probing*	Surface luster – Matt, *Shiny*
Plaque – Sticky, *Not Sticky*	Age of the lesion - <3 years, *>3 years*

* Adapted from Kim Ekstrand

Table adapted from: Young DA, Featherstone DB. Caries management by risk assessment. Community Dent Oral Epidemiol (2012).

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Caries Risk Assessment (CRA)

After careful charting of the existing caries findings, the next step involves determining the patient's caries risk. Due to the array of CRA forms that exist, clinicians are encouraged to read the instructions carefully on the form they use and literature supporting its use. A variety of forms exist from the American Dental Association, American Academy of Pediatric Dentistry, the Journal of the Caliornia Dental Association, and Cariogram. In addition, an iPhone app called "MyCAMBRA" is available. Clinicians are encouraged to consider using a form that best fits their practice philosophy.

Some of the questions on the CRA form are answered by the findings of the hard tissue examination and some require a dialogue with the patient. Once completed, the CRA form helps the clinician assess the presence of caries disease indicators, caries risk factors, and caries protective factors. Using a CRA form (as opposed to doing it from memory) provides reproducibility, as well as continuity of information should a different clinician subsequently perform a risk assessment on the same patient.

As mentioned previously, some clinicians elect to supplement their clinical examinations with additional tests. Tests available include, but are not limited to, biofilm assessment (bacterial culture or ATP Bioluminescence) and saliva analysis (measurement of flow rate, and the pH of stimulated and resting saliva). Individual tests may or may not be mentioned on the CRA Form, depending on which one is being used. The diagnostic capabilities and their limitations should be thoroughly understood before applying the findings to patient care decisions.

ATP Bioluminescence quantifies the amount of adenine triphosphate strands (ATP) that are present within the biofilm, rather than a specific bacterial group such as *mutans streptococci* or *Lactobacillus* species. This technology can provide a different perspective from which plaque bacteria

can be understood. Since all aciduric/acidogenic organisms require more ATP to live under low pH conditions, the acidogenic biofilm activity along with the overall bacterial load can be assessed using this test.[11] A recent clinical trial demonstrated a significant positive correlation between ATP Bioluminescence and the bacterial count in plaque and saliva specimens, including for oral streptococci, as well as, surprisingly, an association with the assessment of caries risk.[12]

The body of research concerning the remaining saliva analysis test fails to provide conclusive evidence concerning which measurements are the most important or predictive. While experts agree pH and biofilm play a pivotal role in caries lesion development, there is a lack of consensus regarding which test should be included in a CRA. As more research is performed, the use of such tests in practice may become more widespread. Many clinicians also see the value of these tests as teaching tools for patients to learn more about their unique oral environment, and to help explain treatment decisions. Simple tests of the resting pH, resting flow rate, stimulated pH, stimulated flow rate, and buffering capacity may prove beneficial in helping patients understand why and possibly how to change their caries risk status. The practice of analyzing saliva is an emerging field within cariology.[13]

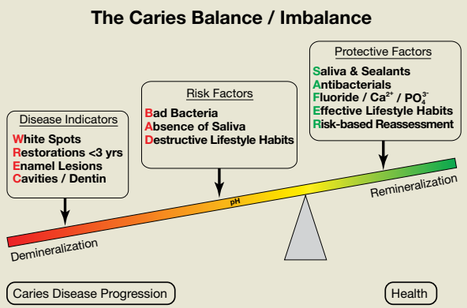


Figure 1. Caries imbalance

Source: Young DA, Featherstone DB. Caries management by risk assessment. *Community Dent Oral Epidemiol*. (2012). With permission, John Wiley & Sons.

Establish a Diagnosis and Prognosis

Using information from the clinical examination, data from any additional tests performed, and the CRA, the clinician is now ready to provide a caries risk diagnosis and prognosis for treatment. With all the objective data in hand, the clinician is able to determine whether a patient has a low, moderate, high, or extreme caries risk level, and thereby determine the therapy to be used for each individual patient. For example, disease indicators include pathological risk factors and protective factors, and are looked at in terms of the caries balance (Fig. 1). It is recommended that clinicians follow the instructions provided on the CRA form that they choose to use in clinical practice.

Low caries risk patients are those who have no caries risk factors and were further defined in a 2006 American Dental Association (ADA) publication[14] as those who have had no caries lesions in the prior 3 years.[14] Moderate caries risk in patients under age 6 is indicated by the presence of one or more caries risk factors, and an absence of caries lesions. In patients age 6 and older, moderate caries risk was additionally indicated by the presence of one or two caries lesions (noncavitated or cavitated).[14] High caries risk in patients under age 6 is indicated by the presence of any caries lesions in the prior 3 years, and/or the presence of several caries risk factors, and/or low socioeconomic status, and/or xerostomia, and/or inadequate fluoride exposure.[14] In patients age 6 and older, high caries risk is indicated by three or more caries lesions in the prior three years, and/or the presence of several caries risk factors, and/or xerostomia, and/ or inadequate fluoride exposure.[14] Extreme risk is defined as high risk plus extreme salivary hypofunction.

The severity of risk, along with the patient's motivation and compliance, will help the clinician determine a prognosis. Lowering the caries risk should reduce caries lesions as well as increase the prognosis for long-term success of any restorative treatment. In other words, a restoration placed in the mouth of a high caries risk patient does not have a good prognosis for longevity unless the patient's risk level is lowered and addressed appropriately.

The previous examples describing risk levels were presented in the ADA evidence-based clinical recommendations for topical fluoride published in 2006. Since then more research has been published with slight differences. One example was a six-year retrospective study presented by Doméjean and others in 2011 where they determined that even one disease indicator (e.g., one caries lesion) was considered high risk. This stresses the need to evaluate the evidence supporting one CRA form you choose to use and it also illustrates that although most caries risk assessment forms evaluate similar items; they are by no means identical nor do they guarantee the risk level determination will be exactly the same. As stated previously the determination of risk should be specific based on the instructions that accompany the CRA form that you are using and instructions should be followed carefully so that evidence-based treatment options may be presented to your patient.[15]

Recommendations for the Prevention and Management of Caries

Once a diagnosis and prognosis have been decided and recorded, the preventive and treatment options can be discussed with the patient. For low caries risk patients of all ages, twice-daily dose-appropriate use of over-the-counter fluoride toothpaste, and fluoridated water, may be all that is required; the application of professional topical fluorides for low caries risk patients is based on clinical judgment for an individual patient.[14] Caries recall visits should occur every 6 to 12 months.[16] Care includes oral hygiene instruction and dietary counseling (Fig. 2).[16] Patients with an elevated caries risk level benefit from additional caries recalls and interventions that help prevent and manage caries.

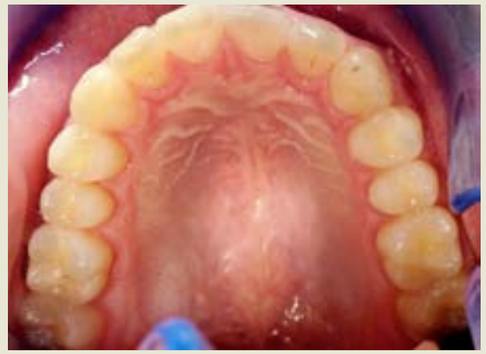
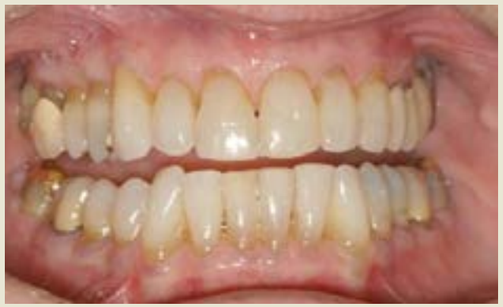
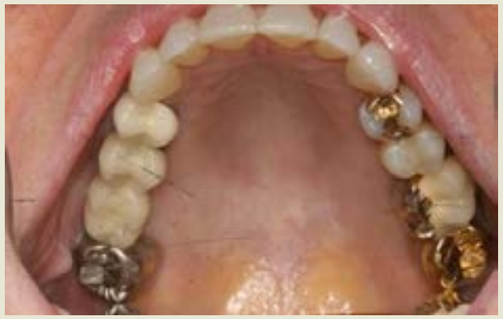


Figure 2. Low risk patient with good oral hygiene, no history of caries, and adequate fluoride exposure

Patients at Elevated Risk for Caries

Moderate Caries Risk: These patients have some risk





Figures 3a and b. High risk patient with gingival recession, exposed roots and recent caries lesions requiring restorations

factors, but several protective factors to help with the caries risk balance. Resting saliva may appear healthy, and pH may be measured as >7, depending on which risk factors the patient has. Caries recall visits are recommended at 4 to 6 month intervals.[16] An example of a moderate caries risk patient would be an orthodontic patient with fair oral hygiene, and who snacks on fermentable carbohydrates on a daily basis. Another example would be a child under age 6 who did not have any clinical evidence of caries (as yet), but whose oral hygiene was inadequate.

High Caries Risk: Examples of such patients include those with approximal lesions and high bacterial challenge (ATP >1500 RLUs), but with normal resting saliva and a pH measuring > 6. Caries recall visits are recommended every 3 to 6 months.[16] An example of a high caries risk patient would be a periodontal patient with inadequate oral hygiene, gingival recession and exposed roots, and evidence or a recent history of root caries (Fig. 3).

Extreme Caries Risk: Extreme caries risk patients have similar risk factors to those of a high caries risk patient, but additionally have hyposalivation. Clinically, the saliva appears thick/bubbly and tissues are dry. Caries recall visits are recommended every 3 months.[16] An example of an extreme risk patient would be an oncology patient who has received head and neck radiation and has little or no remaining salivary gland function. A second example is an older adult with poor oral hygiene, exposed roots, coronal and root caries, and hyposalivation due to the use of multiple medications (Fig. 4).

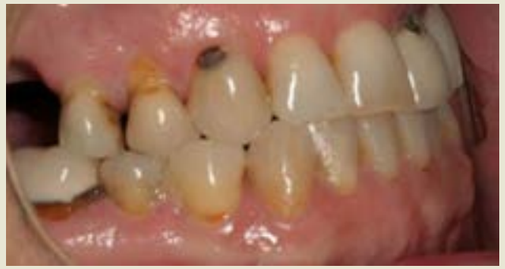


Figure 4. Older adult with medication-induced reduced salivary flow, exposed roots, and active caries lesions

Bitewing Periodicity

Bitewing radiographs for patients with no clinical caries and no risk factors are recommended at 12 to 24 months in children if proximal surfaces in the primary and mixed dentition cannot be assessed visibly or with a probe. For low caries risk adolescents and adults, bitewing radiographs are recommended at 18 to 36 month and 24 to 36 month intervals, respectively.[17]

Radiographs for children and adolescents with caries or an elevated risk for caries are recommended every 6 to 12 months if proximal surfaces cannot be visually assessed, and every 6 to 18 months for adults.[17] The interval recommended between bitewing radiographs is shorter for higher caries risk patients than for lower caries risk patients.[16,17] For example, for extreme caries risk patients, bitewings are recommended every 6 months until no new lesions have been identified.[17]

Treatment Recommendations for Patients at Elevated Risk for Caries

Professional Topical Fluorides

Based on the current recommendations, the only professionally applied topical fluoride recommended for caries prevention in the under-6 age group is 5% sodium fluoride varnish (2.26% fluoride ion).[18] It should be noted that the use of fluoride varnish for caries prevention is off-label in the United States. For patients age 6 and over, either 5% sodium fluoride varnish or 1.23% APF gel applied for 4 minutes is recommended.[18] In the case of patients with exposed roots and sensitivity, sodium fluoride varnish can also relieve sensitivity by occluding the dentinal tubules[19], and home use of a desensitizing toothpaste can also be recommended.

Professional fluoride application for caries prevention in patients at elevated risk for caries is recommended at least every 3 to 6 months.[18] Professionally applied fluorides are provided based on caries risk level, with more frequent applications recommended for higher risk patients.

Prescription-Level Topical Fluorides

The use of 1.1% sodium fluoride gel/paste (5,000 ppm fluoride) or 0.09% fluoride mouthrinse is recommended on a twice-daily basis for patients at elevated risk for caries.[18]

Pit and Fissure Sealants

Pit and fissure sealants are recommended for age-appropriate, site-specific caries prevention on sound pits and fissures in the primary and permanent teeth of patients at elevated risk of caries. They are also recommended for use on early noncavitated caries lesions in pits and fissures in at-risk children, adolescents, and adults.[20]

Other Options

Additional options for elevated caries risk patients can involve the use of over-the-counter 0.05% neutral sodium fluoride mouth rinse,[21] and 6 to 10 grams of xylitol per day. The doses of xylitol can be minimized to three exposures of 2 grams each.[16] A study conducted by Featherstone et al suggests that antibacterial products are also beneficial for higher caries risk patients with high acidogenic bacterial challenge.[22] If it is determined during a caries recall that the antibacterial and fluoride treatments are not as successful as hoped, adding products with calcium and phosphate, and pH neutralization strategies, should be discussed and considered for the patient. Since saliva assessment is not an exact science, hyposalivation might have been missed.

For extreme caries risk patients, treatment recommendations include the incorporation of calcium and phosphate products and pH neutralization. This recommendation is additive to what is prescribed for patients with an elevated risk level but who are not extreme caries risk patients.

Other Treatment Considerations

With respect to home care and the treatment recommended above for elevated caries risk patients, clinicians need to be mindful of the patient's ability to effectively apply these products. Suggesting 5 to 7 products at the initial dental visit may overwhelm the patient; instead, consider patient education and 1 to 3 products initially. If the patient appears to be compliant after caries recall, praising the patient, and further suggestion of additional products may prove feasible for his/her lifestyle.

After the patient is made aware of his/her treatment options using good communication, a customized treatment plan can be created, followed by a written patient letter with specific product instructions. The goal for the patient and the clinician is to help decrease the caries risk level for the long term, by working together as a team.

Conclusion

The current body of evidence in caries management suggests that caries management by risk assessment has real promise to result in effective treatment and prevention of the disease.[14] Using the best available evidence and integrating CAMBRA into clinical practice with a simplified approach to prevent, manage and treat dental caries is a goal that is attainable and measurable for each individual patients.

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Acknowledgment

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CE Quiz

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1. **The bacterial make-up of biofilm, and its ability to create changes dynamically, depends on _____.**
   a. the location of the biofilm on the tooth
   b. pH
   c. the chemistry of the surrounding local environment
   d. all of the above

2. **Commensal bacteria can adapt to survive in a low pH environment and create acid _____.**
   a. given enough time
   b. with the addition of alkaline solutions
   c. with help from existing pathogenic bacteria
   d. all of the above

3. **Introducing caries management by risk assessment into clinical practice is a way to focus on changing deleterious biofilm behavior, by _____.**
   a. decreasing the pathogenic risk factors that cause demineralization
   b. implementing a chemical reversal of the process (remineralization)
   c. scolding the patient for poor oral hygiene
   d. a and b

4. **ATP Bioluminescence quantifies _____.**
   a. the amount of adenine triphosphate strands (ATP) present
   b. a specific bacterial group
   c. the acidity of the intraoral environment
   d. a and b

5. **A radiographic radiolucency in the outer 1/3 of the dentin, is categorized as _____ using the ICDAS system.**
   a. D1
   b. D2
   c. D3
   d. none of the above

6. **Patients with one (or more) cavitated lesion(s) and hyposalivation are _____ risk patients.**
   a. moderate
   b. high
   c. extreme
   d. any of the above

7. **Using a caries risk assessment form _____.**
   a. helps the clinician assess the presence of caries disease indicators, risk factors, and protective factors
   b. provides reproducibility
   c. provides continuity of information
   d. all of the above

8. **Having a caries lesion classification system that measures the _____ of the lesion at all stages of lesion progression is essential in properly treating this disease.**
   a. site
   b. extent
   c. activity
   d. all of the above

9. **Low caries risk patients have no caries risk factors and have had no caries lesions in the _____ years.**
   a. prior 2
   b. prior 3
   c. intervening
   d. any of the above

10. **_____ is an example of a moderate risk patient.**
    a. An orthodontic patient with 1 additional risk factor
    b. A child under age 6 with one risk factor
    c. A periodontal patient with exposed roots, caries lesion(s), and hyposalivation
    d. a and b

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CEQuiz

11. For moderate risk patients, the recommendations discussed for caries recall are every _____ months.
a. 3 to 4
b. 4 to 6
c. 6 to 9
d. 6 to 12

12. For high risk patients, professionally applied 5% sodium fluoride varnish or topical fluoride gel is recommended every _____ months.
a. 1 or 2
b. 3 or 6
c. 6 or 9
d. all of the above

13. A study conducted by Featherstone et al suggests that _____ products are beneficial for high caries risk patients.
a. antigenic
b. pretreatment
c. antibacterial
d. all of the above

14. For extreme caries risk patients, treatment recommendations include the incorporation of _____.
a. calcium and phosphate products
b. pH neutralization
c. professionally applied topical fluoride every 3 months
d. all of the above

15. The interval recommended between bitewing radiographs is shorter for _____ patients than for lower caries risk patients.
a. all adult
b. higher caries risk
c. patients at risk for periodontal disease and caries
d. none of the above

16. Radiographs for children and adolescents with caries or at risk for caries are recommended every 6 to 12 months if _____ cannot be visually assessed, and every 6 to 18 months for adults.
a. occlusal surfaces
b. bifurcation areas
c. approximal surfaces
d. lingual surfaces

17. The evidence-based recommendations support the use of _____ in the under-6 age group.
a. 5% sodium fluoride varnish
b. fluoride gel
c. fluoride foam
d. all of the above

18. Suggesting five to seven products at the initial dental visit may _____.
a. be highly practical
b. overwhelm the patient
c. ensure successful interventions
d. a and c

19. The goal for the patient and the clinician is to help _____ the caries risk level for the long term.
a. manage
b. maintain
c. decrease
d. none of the above

20. Using the best available evidence and integrating CAMBRA into clinical practice with a simplified approach to prevent, manage and treat dental caries is a goal that is _____ for each individual patient.
a. attainable
b. measurable
c. unproven
d. a and b

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CE ANSWER FORM (E-mail address required for processing)

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*Address: | NPI No.

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*Telephone: | License Renewal Date:

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EDUCATIONAL OBJECTIVES

- Describe the caries disease process;
- Discuss the implementation of CAMBRA into clinical practice;
- Define caries risk levels; and,
- Review the evidence-based recommendations for patients with different caries risk levels.

COURSE EVALUATION

Please evaluate this course using a scale of 3 to 1, where 3 is excellent and 1 is poor.

1. Clarity of objectives ..... ③ ② ①
2. Usefulness of content ..... ③ ② ①
3. Benefit to your clinical practice ..... ③ ② ①
4. Usefulness of the references ..... ③ ② ①
5. Quality of written presentation ..... ③ ② ①
6. Quality of illustrations ..... ③ ② ①
7. Clarity of quiz questions ..... ③ ② ①
8. Relevance of quiz questions ..... ③ ② ①
9. Rate your overall satisfaction with this course ..... ③ ② ①
10. Did this lesson achieve its educational objectives? ◯Yes ◯No
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2.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
3.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
4.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
5.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
6.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
7.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
8.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
9.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
10.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
11.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
12.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
13.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
14.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
15.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
16.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
17.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
18.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
19.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
20.	Ⓐ	Ⓑ	Ⓒ	Ⓓ

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Deep Mottling Treated with Direct Veneers

John Comisi, DDS

CASE PRESENTATION

A 17-year-old patient presented to treat deep mottling of teeth Nos. 8 and 9 (Figures 1 and 2).

We suggested trying to microabrade and then infuse an unfilled resin system (Icon) into the areas to attempt to improve the appearance.

Application of the product components, hydrochloric acid (Figure 3), and then infusion of the tooth (Figure 4) were accomplished as directed by the manufacturer. The results were an improvement; however, the patient, her mother, and I were not quite satisfied with the appearance. We then discussed placing cosmetic direct veneers in a minimally invasive procedure using Uveneer (distributed by Ultradent). The parent and patient agreed to the procedure.

We first identified the correct size and shape of Uveneer to use on the central incisors (Figures 5 and 6), selected the appropriate shade using the VITA Shade system (Vident), then isolated with the Isolite System (Isolite) and cotton rolls for the labial aspect (Figure 7).

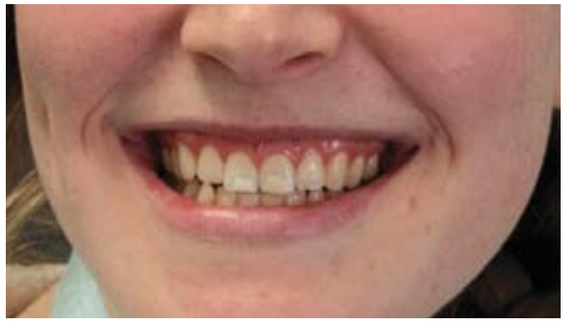
After treating the facial surfaces of both incisors with a medium grit diamond to remove some of the infused resin, we placed ALL-BOND UNIVERSAL (BISCO) on those areas of teeth Nos. 8 and 9, as directed.

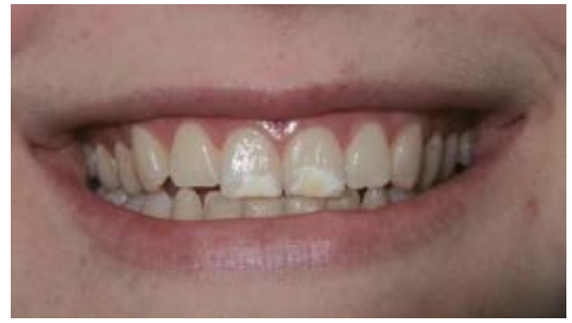
BEAUTIFIL II (Shofu) composite material was placed first on one tooth to mask the mottled area and cover the coronal portion of the tooth, then a small amount of BEAUTIFIL Flow Plus 03 (Shofu) was added to the Uveneer template. The template was then pressed onto the tooth (Figure 8) and aligned with the long axis of the tooth, using the demarcation that runs gingival-incisal on the Uveneer template. Excess material expressed from the margins of the template were cleared and then the material was cured through the Uveneer, maintaining steady pressure on the tooth and keeping the template aligned in the proper orientation. The Uveneer template was popped off (Figure 9) and the area inspected. The next central incisor procedure was performed the same way.

After curing both veneers, trimming and polishing of the new restorations was accomplished using medium and fine carbide composite trimming burs, Super Snap XTreme (Shofu) polishing discs and OneGloss polishers (Shofu). An excellent final result was achieved (Figure 10).

Having these tools in my dental "bag of tricks" makes my day-to-day practice easier and more fun.

Dr. John Comisi has been in private practice in Ithaca, NY, since 1983. He is a graduate of Northwestern University Dental School and received his Bachelor of Science in Biology at Fordham University. Dr. Comisi has lectured nationally and internationally and has contributed to the dental literature. He is a member of *Dental Learning's* Editorial Advisory Board and a member of the National Dental Practice-Based Research Network as well as the International and American Association of Dental Research.





Figures 1 and 2—A 17-year-old patient presented with deep mottling on teeth Nos. 8 and 9. The patient and her mother wanted esthetic improvement to these teeth.

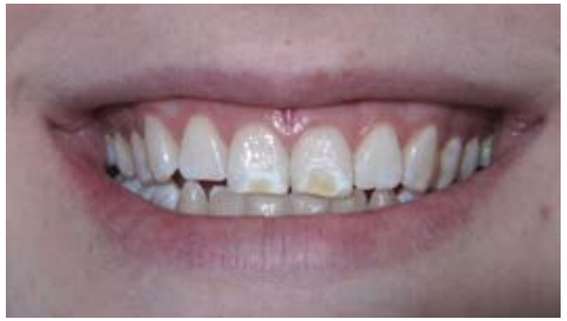


Figure 3—The patient and parent agreed to try microabrasion of the central incisors, followed by infusion of an unfilled resin (Icon). The image above shows the teeth after application of the product components and hydrofluoric acid.

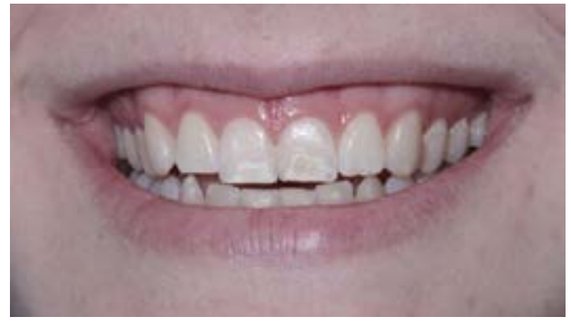
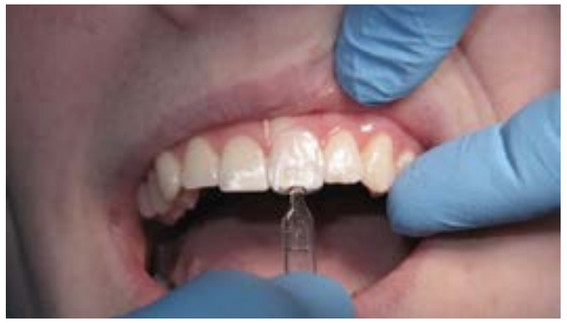
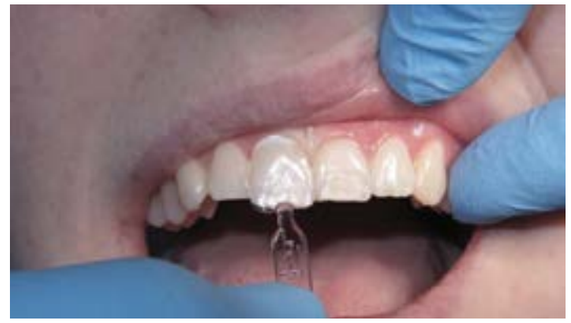


Figure 4—Photo of teeth Nos. 8 and 9 after infusion of the unfilled resin. While the result is significantly better, the parent, patient, and I were not satisfied with the result.





Figures 5 and 6—The patient and parent agreed to placing cosmetic direct veneers in a minimally invasive procedure. For this case, we chose to use Uveneer (distributed by Ultradent). The first step involved determining the correct shape and size of Uveneer for each tooth.

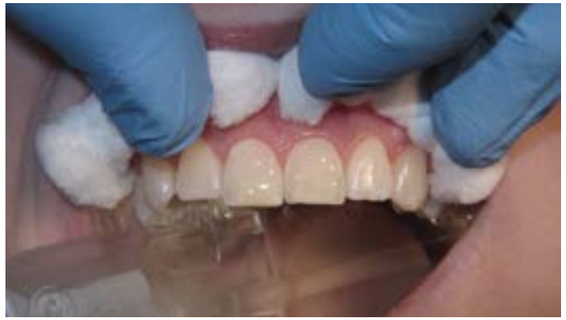


Figure 7—After selecting the appropriate shade using the VITA Shade system (Vident), we isolated using the Isolite System (Isolite) and cotton rolls.

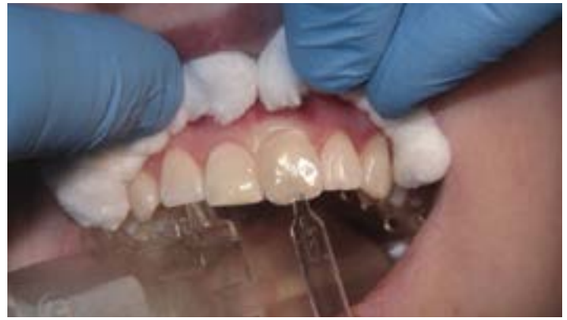


Figure 8—For each tooth, BEAUTIFIL II (Shofu) was placed to mask the mottled area and cover the coronal portion of the tooth. A small amount of BEAUTIFIL Flow Plus 03 (Shofu) was then added to the Uveneer template. This image shows the template being pressed onto the tooth and aligned with the long axis of the tooth, using the demarcation that runs gingival-incisal on the Uveneer template.

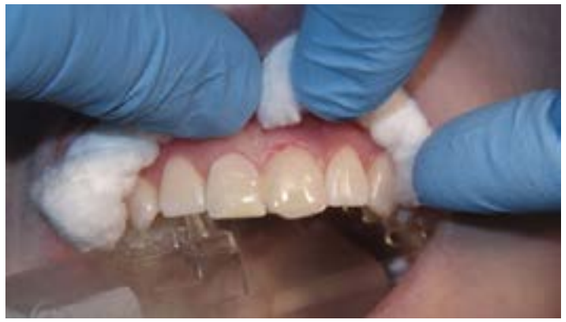


Figure 9 The Uveneer template was popped off and the area inspected.

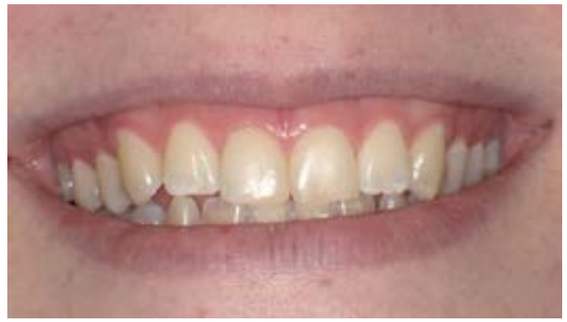


Figure 10—Both veneers were cured, followed by trimming and polishing of the new restorations using medium and fine carbide composite trimming burs, Super Snap XTreme (Shofu) polishing discs, and OneGloss polishers (Shofu). This photo shows the esthetic final result.

Proper Clean-Up: *Removing Excess/Residual Resin-Based Dental Cement*

ABOUT THE AUTHOR

Louis Kaufman, DDS, MBA, BA

Dr. Kaufman is a nationally recognized speaker and author. He also serves on the advisory boards of several dental product manufacturers and consults on product development. Dr. Kaufman has a private practice in Chicago, IL.

Introduction

The primary functions of dental cements are to enhance resistance to displacement and to seal the interface of the restoration to the remaining tooth structure. Available options include, but are not limited, to composite resin cements and resin modified glass ionomers. Proper selection of dental cements is a key factor that increases the success of restorations. Several factors determine which type of dental cement, restorative material, and restoration a clinician chooses, including the ability to maintain a dry field, esthetic demands, tooth structure, the location of margins and chewing forces.

Resin cements were introduced in the 1970s as an alternative to acid-based reaction cements such as zinc phosphate. These cements vary in their setting mechanisms, which consists of polymerization either by chemical curing, dual curing, or light curing. Resin cements offer good adhesion (and therefore retention) as well as low solubility once set and good compressive strength. They are, however, technique-sensitive, require careful clean-up, and excess cement is generally difficult to remove once set.

Resin-modified glass ionomer cements contain resin filler particles consisting of polymerized functional methacrylate monomers. These monomers modify glass ionomer cements which consist of powder containing fluoroaluminosilicate with a liquid that is composed of polyacrylic acid and tartaric acid. When mixed, the polyacrylic acid reacts with the particles and releases aluminum, calcium, and fluoride ions. Resin-modified glass ionomers offer improved adhesion, strength, and low solubility. In addition, they are easier to manipulate than glass ionomer cement. The working time is affected by temperature: high temperatures shorten the working time while low temperatures prolong it.

Proper use and clean-up of dental cement

Proper use and clean-up of dental cements ensures the success of restorations and aids in preventing postoperative complications associated with residual cement. Effective removal of excess cement is important in the prevention of gingival bleeding, soft-tissue inflammation, crestal bone loss, and peri-implant disease. The presence of dental cement is a direct result of poor clean-up and use, as well as lack of assessment of residue after cementation. Residual cement can be extremely difficult to remove from subgingival areas,

making proper handling at the time of cementation crucial. To reduce the possibility of problems associated with the use of dental cements, several aspects need to be considered.

Appropriate amount of cement and placement

Proper preparation and resistance form help avoid overuse of cement. A thin layer of cement, which for crowns amounts to about 3% of the volume of the crown, should be all that is required (Fig. 1). Application of the cement near but not on restoration margins helps prevent excess cement from building up. When the crown is seated, the cement will flow toward the occlusal table of the preparation and then move to the preparation margins where the excess cement is then readily extruded. Another approach is the placement of a cement vent that helps to minimize hydraulic pressure that could otherwise push the cement subgingivally. Retraction cord also can aid in easy clean-up of excess cement.

Using silicone as a "cementation device" has been

Figure 1. Thin layer of cement in crown

described in the literature. Silicone is first injected into the crown to create an analog. Cement is then placed in the restoration, first seated over the analog to displace most of the excess, and then removed and seated over the preparation. Care must be taken if using this technique to work quickly to avoid the onset of initial setting before the restoration is fully seated over the preparation.

Working and setting times

Working times and setting (or curing) times are important to understand when handling a cement:

- The working time is the time available for the manipulation of unset cement
- The setting time refers to the time that is required for the cement to set or harden from its plastic or fluid stage to a rigid one.

Since the working and setting times are different for each cement and vary by manufacturer, it is critical to read the instructions. Long-term success is heavily dependent not only on appropriate selection but also on proper handling and use of dental cements. It is extremely important that all excess cement be removed. This requires a careful technique and an understanding of when during the setting reaction excess cement may be initially removed. Various approaches can be taken to remove excess cement and minimize the risk of residual cement.

Excess cement removal at the restorative margins

Clean-up of resin-modified glass ionomer and glass ionomer cements is easy, as the excess cement can be removed with a plastic instrument or scaler while in the waxy stage. With a dual cure composite resin–based cement, in the case of ceramic restorations that transmit light, using a curing light for 1 to 2 seconds tack cures the cement, making it possible to peel away the excess with an anterior or posterior scaler while the cement is still waxy/rubber (Fig. 2), and then following this up by using an explorer.

For cementation of opaque metal- and zirconia-based restorations, however, there is a risk with removing excess dual-cured cement using the tack curing method as the excess cement at the margin will be cured, but not the cement

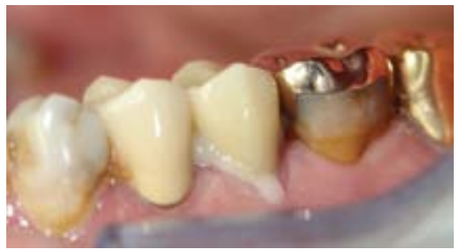


Figure 2. 'Peeling off' the excess cement

under the restoration since light cannot penetrate through the opaque restoration. Mechanical forces involved during cleanup can weaken or cause failure of the bond if the cement is not sufficiently cured. Therefore, it is recommended for these restorations that the cement be self-cured to reach the gel phase, at which point excess can then be conveniently and safely removed.

Timing is important - if cleanup begins before cement reaches a gel state, then premature failure of the restoration can occur. Conversely, if cleanup is late the cement will already have set, making removal of excess cement difficult without rotary instrumentation. For optimal cleanup results, it is important to check the excess cement closely to determine when it reaches the gel phase, during which excess cement can be safely and efficiently removed. It is also important to follow the directions for use, which should indicate when the gel phase will commence.

Floss also can be used at this stage to remove excess cement, as well as afterwards to remove loose excess in the gingival sulcus, help remove adhered excess, and to check that no residual cement remains. Methods for removing residual cement, beyond the use of floss and scalers for hard set cement, include cleaning with a water and pumice paste and prophylaxis cup, and using an intraoral sand blaster. Of all three, the sand blaster has been the most effective and manual removal the least effective. All surfaces of the tooth should be cleaned, especially the margins.

Removal of residual dental cement around implants

Floss is also used around implant restorations to detect and help remove residual cement. After inserting the floss on both sides of the implant, it is wrapped in a circle and crisscrossed and then moved in a shoeshine motion in the peri-implant crevice. Great care should be taken during removal of residual cement to minimize trauma to the peri-implant tissues, and to avoid roughening the neck of the implant (if exposed) and implant complex–restorative interface (Figs. 3, 4). Titanium implant scalers can be used to debride the area and dislodge excess cement. These are preferred over graphite and plastic scalers that may leave traces of graphite or plastic embedded in the rough surfaces of implants, which may increase the risk of peri-implantitis. Titanium implant scalers are strong enough to remove hard cements, yet have a low Rockwell hardness to avoid scratching implant surfaces.

Clinical and radiographic visualization

Good visualization and moisture control is essential when placing indirect restorations. Good visualization also aids with removal of excess cement. Proper visualization can only be achieved through the use of magnification. Loupes are invaluable in providing this for dentists, dental hygienists, and assistants. Using a dental mirror defogging solution also helps, and systems such as the Isolite system allow for improved visualization with an intraoral light incorporated

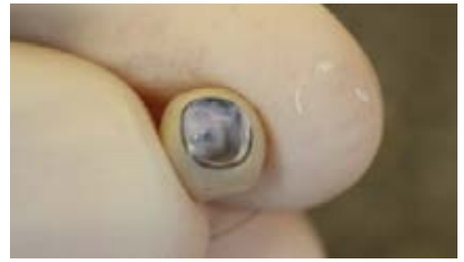


Figure 3. Cement placed in an implant crown

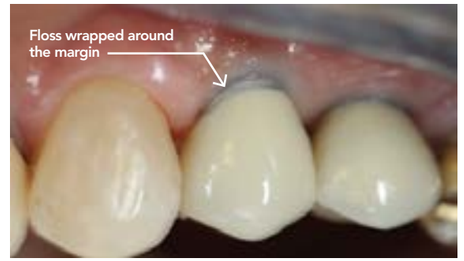


Figure 4. Implant crown cemented, all excess cement removed. Note the floss wrapped at the buccal gingival margin used in a shoe shine motion.

into the device, in addition to providing for isolation.

There are various methods for identifying excess cement. A common method is to use dental tape floss; if the floss is roughened or frayed after being used around the indirect restoration, this can be indicative of residual cement. (Note, however, that adjacent overhangs and calculus also can result in frayed or roughened floss.) It is important to use a radiograph to check for residual cement. It is therefore necessary to select a cement with radiopaque properties so that it can be detected radiographically. In some cases, the removal of excess cement may require use of a local or topical anesthetic so that the cement can be effectively and painlessly removed.

Surgical removal of old residual cement is only recommended if nonsurgical removal is unsuccessful. This involves flap surgery to help identify, access and remove residual cement that is located 3 mm to 5 mm subgingivally. While it may be successful, it is invasive and traumatic and represents a failure at the time of treatment planning and restoration.

Conclusion

The risk of residual cement can be avoided and minimized by understanding the properties of different cements, through proper selection and handling. Practitioners should be aware of the point at which excess cement may easily be removed for a given cement, and a thorough check should be made to identify any residual cement and remove it before the patient leaves the office. By using modern technology and tools available in dentistry, it is possible to eliminate the threat posed by residual cement.

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Isolation and Digital Dentistry

ABOUT THE AUTHOR

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Dr. Ricci attended the University of Texas Health Science Center at San Antonio, receiving his dental degree and completing an Advanced Education in General Dentistry residency. He has been awarded his Fellowship in the Academy of General Dentistry, as well as selected as Texas Young Dentist of the Year by the AGD. Dr. Ricci, has also been recognized by D Magazine as one of the Best Dentists in Dallas. He has served in many leadership roles including President of the Dallas Academy of General Dentistry, Board of Directors for the North Texas Dental Society, and as Director of the Young Dentist Study Club. He maintains a private group practice in Plano, Texas.

Introduction

Isolation of the dental working field is one of the most important, and yet sometimes most underappreciated, aspects of restorative dentistry within our control. Creating a repeatable and comfortable protocol for isolation of the treatment area not only allows the clinician to provide the highest quality results and consistency in their dentistry, but also increases patient comfort, safety, and satisfaction.

For many clinicians, the demands and increasing patient loads of a growing practice cause them to sideline ideal isolation of the working field in favor of the perception of seeing more patients, or improving the patient experience and comfort. Often this perception is flawed. In fact, it can work against the clinician, causing discomfort, and increasing the time spent wrestling with curious tongues and productive salivary ducts. With a few tweaks to your current protocols, you can enjoy the benefits of ideal isolation, patient comfort, and workflow. You can have your cake and eat it too.

In dentistry, isolation is defined as the "…separation of a tooth or group of teeth from oral tissues and saliva by use of a dental dam, cotton rolls, or other means to improve access, visibility, and control moisture contamination while restorative or operative dental procedures are performed." Ultimately, that is just a fancy way of saying keeping the spit, blood, and gunk out of the working field. We all remember our dental school days and how the restorative faculty pounded into our heads the importance of using a rubber dam when performing restorative procedures. I also can remember the frustration of having a rubber dam split when I was chin deep in an arch of approximal restorations.

Is it really so beneficial to use the rubber dam? Did those faculty members just make us do it for their twisted amusement? I would argue that, in fact, it is one of the most critical things we learned. As many young dentists begin in practice, they continue using the rubber dam until it becomes perceived as a hindrance more than a help. While there are certainly some drawbacks to the rubber dam, the benefits of proper isolation of the working field vastly outweigh the inconveniences, and there are even options that can provide the isolation benefits without the drawbacks.

4 Key Benefits of Isolation

In my practice, I have established that isolation of the dental field provides 4 key benefits:

1. Improved clinical outcomes
2. Patient comfort and safety

3. Efficiency of workflow
4. Team safety.

I think we can all look at that list and see that these areas are of great importance to us, not only as practitioners, but also wearing our hats as business owners, managers, and patients.

1. Improved clinical outcomes

Peer-reviewed dental journals over the years have been replete with literature pertaining to the adverse outcomes related to contaminants being present on the surfaces we are trying to restore. Bond strengths of restorative materials to enamel and dentin decrease significantly when contaminated by saliva, blood, water, or any debris. Beyond that, it is much easier to consistently create ideal preps, improve restoration morphology, and to powder and capture intra-oral images with a digital scanner when isolation is adequate. Clearly, when the tissues and fluids of the oral environment are controlled, and visibility is at its best, we can provide our best work.

2. Patient comfort and safety

Keeping the oral tissues retracted and controlled significantly reduces the risk of trauma. Isolation further protects the airway and reduces the risks of aspirating or swallowing debris or foreign objects. Additionally, patients are much more comfortable if they don't have to taste the sometimes unpleasant-tasting substances we use.

3. Efficiency of workflow

If too much time is devoted to wrestling with the tongue or trying to accomplish adequate visualization, it reduces the amount of time that can be spent on actual dentistry, with the result that more chairside time is necessary to complete procedures. Using proper isolation can allow the clinician to work more efficiently by minimizing interruptions while working on single or multiple teeth at one time. This is especially true when trying to restore full quadrants, as it is very difficult to maintain good isolation for the length of time necessary to restore 3 to 4 teeth in an arch.

4. Team safety

One drawback of using water as a cooling spray with an air-driven handpiece is the fact that we aerosolize blood, saliva, and anything contained therein. Many of us have seen the black light pictures of how far our aerosol sprays actually travel, and it is generally much farther than any of us would have guessed. While there has never been a confirmed case of disease transmission through dental aerosols, it makes common sense that the better we reduce bacterial aerosols the better.

The Best of All Worlds

For many years my practice used the rubber dam as the primary method of isolation. There were always battles using it though. Patient acceptance, difficulty with placement, dams tearing during procedures, inability to easily remove it, and clamp trauma to the soft tissue to name a few. Despite the drawbacks and struggles, we persevered, understanding that isolation is a key element to clinical success. I still believe in the requirement of having good isolation, but over the past few years my primary isolation method has changed. With this change in method, I also have seen a change in patient, staff, and my own happiness.

Introducing the Isolite (Isolite Systems) into my practice has been a game changer. I used to see a schedule full of direct restorations in multiple quads and I would shudder, knowing I was going to have to place a rubber dam, maybe anesthetize the palatal tissue so that clamp placement was comfortable for a patient, and then move the dam multiple times for the quadrants I would be restoring.

Now I see these cases on my schedule and instead of cringing, I am excited to see a full schedule. My efficiency and productivity have increased. I am easily able to prep and then restore an upper and lower quadrant at the same time, something I was never able to do with the rubber dam. I am confident that the constant suction provided by the Isolite is going to improve my patient's comfort, constantly ejecting saliva through its continuous suction, and also keep my working field in perfect conditions for my best clinical dentistry. If my patient needs a break, the device can be removed and then replaced in seconds. The airway is protected from debris and foreign objects, avoiding aspiration. All of these advantages, and still a perfect isolated working field. As I said earlier, it appears you can have your cake and eat it too.

Digital Dentistry Case Study

With the ever-increasing presence of in-office digital scanners and milling units, isolation is as important as ever in capturing digital images and cementing final restorations. It is also imperative to have ideal isolation to stay efficient when you are trying to provide your patient with same-day restoration. Using the Isolite aids in accomplishing all of these tasks.

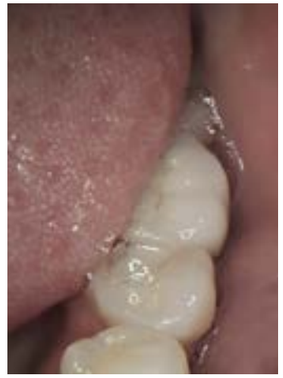

Figure 1—Unisolated working field for tooth No. 18

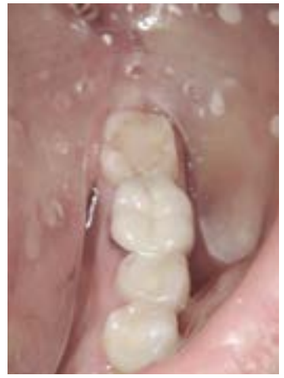

Figure 2—Working field with Isolite placed

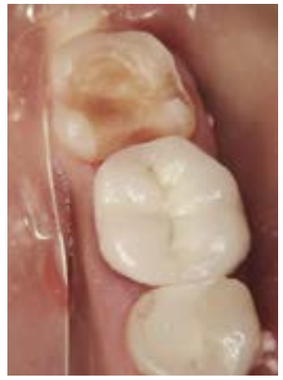

Figure 3—Removal of prior restoration and caries

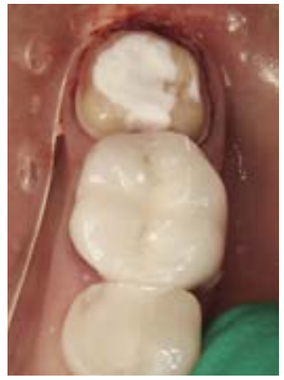

Figure 4—Build-up and cord placed; and tooth No. 18 prepared

Figure 5a—Capturing the intra-oral image

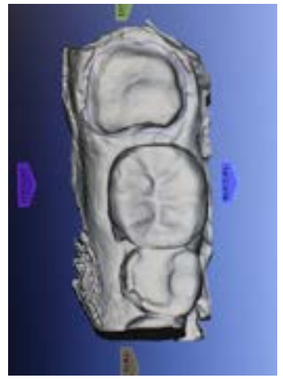

Figure 5b—Digital image of prepared tooth

This case involved a crown and build-up on tooth No. 18, which presented with extensive approximal caries and a previous large composite restoration. Tooth No. 18 can be a challenging location to gain access due to several factors including a restrictive inter-occlusal working space, over-zealous tongue movement, excess saliva accumulation, as well as buccal and lingual soft tissues (Figure 1). With the Isolite in place, most if not all of these problems are resolved (Figure 2).

The existing restoration and all caries were removed, and proper removal of caries was confirmed with caries detection stain (Figure 3). The build-up was then performed using Scotchbond Universal (3M ESPE) and Build-It FR Opaceous White dual-cure build-up material (Pentron). The tooth was then prepped to the preferred dimensions for a full coverage e.max Milled restoration (Ivoclar) and a size #1 Ultrapak Retraction Cord (Ultradent) was placed (Figure 4).

An intraoral digital scanner was used with the Isolite still in place for ideal isolation, to capture the image of the tooth and all extensions of the preparation margins and adjacent teeth

Figure 6—Milled restoration in "blue block" phase

Figure 7—Custom staining and glazing

(Figures 5a and 5b). The crown was then designed and milled using 3M e.max Milled porcelain blocks in shade A2 (Figure 6). After custom staining and glazing the "blue block" phase of the crown (Figure 7), it was then fired in a porcelain oven.

The crown was then removed from the porcelain oven to cool (Figure 8). The intaglio surface was air abraded to remove debris and the internal surface was etched with porcelain etch according to the manufacturer's directions. Silane was placed, scrubbed on the surface for 40 seconds, and then air dried. The final restoration was cemented (Figure 9) with RelyX Unicem 2 (3M ESPE), tack cured, and excess cement removed. Any necessary occlusal adjustments and polishing were performed after cementation.

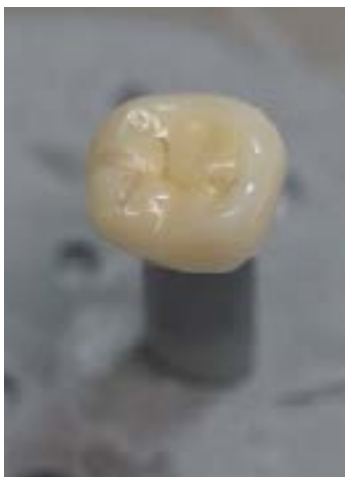

Figure 8—After firing in porcelain oven

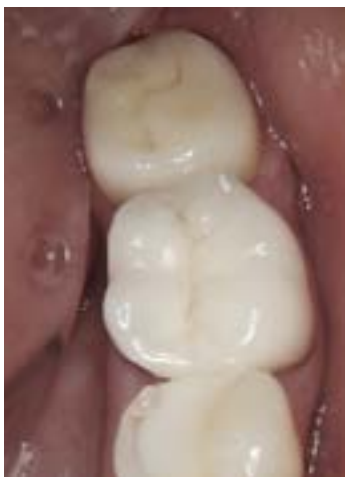

Figure 9—Final cementation

Conclusion

With so many aspects of dentistry requiring attention to detail, and technique-sensitive application, it is imperative to have excellent isolation of the working environment to produce consistent and superior results in a safe and comfortable manner. The more we can increase the key benefits of isolation, while simultaneously decreasing the potential difficulty of isolation, the more likely we are to achieve unwavering consistency.

As this case demonstrates, isolation can be achieved through all phases of restorative treatment in a manner that is beneficial to both the patient and practitioner. It truly is a win-win for both the dentist and the patient. Patients in my practice strongly prefer the comfort of the Isolite over rubber dam isolation. Tooth No. 18, under traditional circumstances, would be a very challenging tooth to restore with a rubber dam. Where would you place the clamp? Would it interfere with your build-up or margin placement on your preparation? With Isolite isolation these concerns go out the window and you can produce ideal dentistry with confidence.