Screw retention for single-tooth restorations on dental implants is often advantageous, as it facilitates crown removal should an adverse event occur, or if modifications to the prosthesis design are anticipated. Prosthetic alterations can be problematic, however, if the screw-access hole is not optimally placed to allow clinical access without compromising function or aesthetics. Contemporary nanocomposite materials are durable enough to function as definitive prostheses in the posterior region, and they may rival porcelain aesthetics intraorally to enable placement in the anterior region. This article presents a technique for fabricating an aesthetic, single-tooth restoration using nanocomposite materials and precontoured abutments to address potential concerns related to screw retention.

Learning Objectives:
This article presents the use of an aesthetic, single-tooth prosthesis fabricated using a nanocomposite material and precontoured abutments. Upon reading this article, the reader should:

• Understand the potential complications that can result in single-tooth restorations if the screw-access hole is not optimally placed.
• Recognize the benefits of nanocomposite materials and precontoured abutments in reducing or eliminating the need for restorative modifications.

Key Words: nanocomposite, implant, abutment, single tooth

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Replacement of a single missing tooth can present a variety of clinical challenges, depending on jaw location and the selected mode of restoration. While the fixed partial denture (FPD) has been traditionally used to optimize function, the use of a short pontic and ridge lap in the anterior maxilla can compromise aesthetics and oral hygiene. In the posterior molar region, aesthetics may be less of a concern. In this clinical circumstance, a conventional, cantilevered pontic may restore function, but will subject the prosthesis and supporting teeth to unfavorable biomechanical forces. In contrast, a removable partial denture (RPD) may provide an acceptable aesthetic appearance, but may also compromise function and survival of the adjacent teeth used to stabilize the prosthesis. An RPD may also be undesirable to the patient because of its removable nature and tendency to trap food. Implant-supported, single-tooth replacement is a treatment option that can restore full function and aesthetics without altering or damaging the adjacent teeth. Documented success rates of approximately 95% with 60 months of clinical follow-up suggest a favorable prognosis, and may even provide an improved cost-effectiveness ratio compared to a conventional FPD.

In designing an implant-supported, single-tooth prosthesis, the choice between cement and screw retention has traditionally been predicated on clinician preference and the requisites of the case. When a change in prosthesis angulation is required, cement has generally been favored if the need for screw access would result in aesthetic or structural complications (e.g., on the facial or incisal surface of the crown). The ability of cement to fill interfacial voids can also ameliorate dimensional discrepancies between the coping and abutment to help achieve a passive fit between the components.

A traditional argument against cement retention has been that abutment retrievability is more complex and costly if changes or repairs are needed. Undetected cement leakage in the region of the prosthesis base has also been a documented cause of peri-implant marginal bone loss. While screw retention has been favored because it facilitates prosthesis retrievability for implant monitoring or prosthesis repair, the implant-abutment interface and abutment screw are subjected to greater lateral bending loads, tipping, and elongation than bilaterally splinted implants in edentulous cases. This may increase joint opening and screw loosening in screw-retention restorations. Interfacial gaps between a cast abutment
and implant have also been cited as causes of chronic inflammation in the surrounding soft tissue.3

Regardless of the type of prosthetic retention, the stability of the abutment-implant screw joint is fundamental to the long-term success of the restoration.3 When an abutment screw is threaded into an implant, the initial tensile preload generated within the screw places the implant-abutment assembly into compression, optimizing the integrity of the screw joint and supporting the abutment against horizontal micromovements and occlusal shear loads.6,7 Under prolonged occlusal loading, however, the machined irregularities on the interfacial surfaces of the mated abutment screw and implant threads may begin to flatten or wear. This has been reported to reduce the initial preload clamping force from 2% to 10%.5-7 This settling or embedment relaxation of the threads may result in horizontal slippage or micromovement at the implant-abutment interface.7 Such variance in horizontal stability, coupled with abutment tilting from nonaxial forces and occlusal stresses, has been cited as the leading cause of screw loosening.7-10 Other contributing factors include inadequate screw tightening, poor prosthesis fit, occlusal overload, wide manufacturing tolerances, and poorly manufactured restorative components (eg, custom abutments).8 Today, improved manufacturing tolerances at the implant-abutment interface and establishment of torque limits for tightening prosthesis and abutment retention screws have greatly reduced the traditional complication of screw loosening.11-13

In addition to improved screw-joint stability, newer composite resin restorative materials and techniques can eliminate many of the aesthetic challenges traditionally associated with screw-retained restorations. Many clinicians are unaware, however, that composite resin materials can be used for definitive dental implant restorations, as the published literature is limited and refers predominantly to provisional use of composite materials.14

Working Cast with Soft Tissue Replica
A working cast that contained replicas of the patient’s implants and surrounding soft tissues was required for accurate indirect construction of the prostheses. Impression posts were attached to the implants intraorally, and the screw-access holes were blocked out with soft utility wax to prevent the ingress of impression material. A full-arch impression was fabricated with heavy- and light-body material in either a stock or custom tray. Following the setting of the impression material, the tray and impression

Figure 5. Abutment clearance was evaluated with an articulated opposing arch cast to ensure sufficient space for the definitive prosthesis.

Figure 6. The abutments were slightly modified for occlusal clearance.

Figure 7. The abutment base was blocked out with putty to preserve the soft tissue interface.

Figure 8. View of the blasted abutment crest. Note the smooth base for soft tissue contact.
Practical Procedures & Aesthetic Dentistry

posts were removed. At this time, the healing collars could have been reattached to the implants (eg, Tapered Screw Vent, Zimmer Dental, Carlsbad, CA), in order to maintain the soft tissue openings. The patient was dismissed until the prosthesis-delivery appointment. Each impression post was attached to an implant analog and placed back into its impression site. A small amount of soft tissue replica material (eg Permasoft, Dentsply Prosthetics, Austenal, York, PA) was placed into a syringe and injected around the analogs in the impression (Figure 1). When the soft tissue material had cured, the impression was poured in dental stone, and the working cast was separated from the impression after the stone set (Figures 2 and 3).

Abutment Selection and Preparations

Restorative abutments may be ordered either immediately following implant placement and impression making, or anytime following evaluation of the working cast. While conventional straight abutments may be used, the use of one that is precontoured and approximates the shape of a prepared tooth can reduce or eliminate the need for laboratory modifications, decreasing additional treatment time and cost. Selection of precontoured abutments was determined by the amount of required gingival cuff height, as measured from the crest of the implant to the point of emergence from the soft tissue (ie, approximately 1 mm to 3 mm).

For single-tooth restorations, antirotational stability is essential to prevent screw loosening and maintain the peri-implant tissues. Binon reported that achieving a “virtual cold weld” between the mating geometry of the implant and abutment assembly could completely eliminate abutment rotational movements and vibration and tipping associated with screw loosening. This technique could also shield the abutment screw from excessive occlusal forces, by transferring stresses down into the body of the implant, where they are dispersed in bone. Using two-dimensional, axisymmetric, finite element analysis (FEA), a “dished” implant-abutment interface could reduce horizontal stresses and create a more favorable mechanical condition for peri-implant bone maintenance, in comparison to a traditional flat or butt-joint mating surface. These considerations for platform stability can greatly enhance the outcome of nanocomposite, single-tooth restorations.

The selected precontoured abutments (eg, Hex-Lock Contour Abutments, Zimmer Dental, Carlsbad, CA) were attached to the implant analogs in the articulated working cast (Figure 4), and the need for any modifications (eg, vertical height adjustment) was determined via inspection of the intra- and interarch relationships (Figures 5 and 6). The screw-access hole was occluded with a cotton pellet, and the abutment base was blocked out with putty (Figure 7). The top of the abutment was sandblasted (eg, Microetcher ERC, Danville Engineering, San Ramon, CA; Micro-Etcher II Intra-Oral Micro Sandblaster, DynaFlex, St. Louis, MO; Clinical Sandblaster, Henry Schein, Melville, NY) to enhance bonding by the nanocomposite material. A dull finish was notable after sandblasting (Figure 8).
Metal primer (eg, MTL-V, Parkell Products, Edgewood, NY; Alloy Primer, Kuraray Dental, New York, NY; Metal Primer II, GC America, Alsip, IL) was applied to the abutment to enhance the bond, then an opaquer was applied to block out the metal head. Opaque cement (eg, C&B-Metabond, Parkell Products, Edgewood, NY; RelyX Veneer Cement, 3M ESPE, St. Paul, MN; C&B Cement, Bisco, Schaumburg, IL) was ideal for this situation, as it both opaqued and bonded to the metal extremely well, and was easily painted on the abutment. Inserting a microbrush shank into the abutment’s screw-access channel during this procedure helped prevent the opaquer from flowing inside the abutment and blocking screw access and removal (Figures 9 and 10). Alternatively, a precontoured or custom zirconia abutment may be used, which would eliminate the need for opaque coating.

**Nanocomposite Crown**

Dental composite resins are a mixture of monomers, initiator systems, stabilizers, and pigments that offer excellent aesthetic potential and acceptable longevity as restorative materials. Composite materials are generally classified according to the distribution and particle size of the filler phase, which—together with the matrix component—dictate most of the material’s fracture toughness, elastic modulus, polishability, and optical characteristics. Microfilled composite resins offer the potential for high polish and enamel-like translucency, but are contraindicated for the heavy, stress-bearing, posterior jaw location. They are generally filled 35% to 50% by weight with prepolymerized silicon dioxide filler particles (ie, 0.02 µm to 0.05 µm particles). Hybrid composite resins are usually filled 70% to 80% by weight with a heterogeneous aggregate of filler particles (ie, 0.04-µm and 1-µm to 5-µm particles), which assists in maintaining their gloss.

Nanocomposite (or nanofilled composite) resins contain fillers that consist of nanomers (ie, 5-nm to 75-nm particles) and nanoclusters (ie, 0.06-µm to 1.4-µm particles) of primary zirconia/silica nanoparticles (ie, 5-nm to 20-nm in size), which are fused together at contact points. The resulting porous structure is fused together with silane. The mechanical and physical properties of nanocomposites and hybrid composites are similar, but nanocomposites maintain polish and gloss significantly better. Nanocomposites are presently being advocated as an option for definitive inlay, onlay, and full crown restorations in conventional dentistry. The ability to use these materials indirectly may greatly facilitate their use for implant restorations, and allow for superior, deeper curing and polishing. The result is a restoration that rivals porcelain in intraoral appearance, wears like enamel, is repairable, and may offer improved resiliency in areas where occlusal stresses are a concern.

A nanocomposite denture tooth (ie, Condyloform II NFC, Geneva Dental North America, Beverly Hills, CA) (Figure 11) that fit the edentulous space was selected and prepared to fit over the abutment.

**Figure 12. Interproximal and occlusal adjustments were made to ensure the fit of denture teeth.**

**Figure 13. Screw-access holes were drilled through the denture teeth.**

**Figure 14. Denture teeth were luted to the abutments to ensure proper function.**
A second method of fabrication could be performed by building up nanocomposite material around the abutment head in layers to form the crown. This procedure could be performed freehand, although a matrix fabricated from the original tooth prior to implant placement can facilitate the procedure. Each layer of composite should be light cured (eg, StepLight SL-I, GC America, Alsip, IL) before the next layer is added. A variety of shades and opaques could be used to characterize and modify crown shade.

The completed crown-and-abutment assembly was light cured according to the manufacturer’s specifications. A light-curing laboratory light (eg, Triad, Dentsply International, York, PA; Labolight, GC America, Alsip, IL) was required for this step. An air-barrier coating was applied to the crown and abutment to prevent adhesion of debris. A sable brush was used to blend the composite between the two. Excess filler material was ground off, and the tissue side was shaped with conventional discs and points. The combination crown-and-abutment prosthesis was attached to the implant analog in the working cast to verify contacts and occlusion, and any necessary adjustments were made. An air-barrier coating was applied to the prosthesis, and then light-curing was performed. Final polishing was accomplished with various points, brushes, pumice, and polishers (eg, Diapolisher, GC America, Alsip, IL; Diamond Restoration Polish, Vident, Brea, CA; Pumice, Whip Mix, Louisville, KY). If desired, a thin coat of light-curing sealant (eg, Palaseal, Heraeus Kulzer, Armonk, NY; Clinpro Sealant, 3M ESPE, St. Paul, MN) could be applied to the prosthesis and cured according to the manufacturer’s instructions.
screw, an extra implant analog (eg, Palaseal, Heraeus Kulzer, Armonk, NY; Clinpro Sealant, 3M ESPE, St. Paul, MN) could also be applied to enhance the glaze. This technique, using nanocomposite denture teeth, yielded the same result as creating the crown freehand with composite material, but with significantly less laboratory time and effort (Figure 16).

Definitive Prosthesis
The definitive prosthesis was placed intraorally, and contacts were carefully adjusted as the abutment screw was tightened to 30 Ncm of applied torque. Final occlusal adjustments were made (Figure 17). The screw-access hole was occluded with a cotton pellet and temporary filling material (eg, Cavit, 3M ESPE, St. Paul, MN; DuoTEMP, Coltene Whaledent, Cuyahoga Falls, OH; Interval II Plus, Temrex Corporation, Freeport, NY) to facilitate future retrieval, and then sealed with additional nanocomposite material. The occlusal or labial surface was repolished to complete the case, and successful results were observed in a one-year follow-up (Figure 18).

Discussion
While nanocomposite materials have been advocated for provisional implant-supported restorations, the author has successfully used this technique for definitive implant restorations and achieved excellent results. By eliminating the need for extensive abutment modifications and longer preparation times, this technique can offer clinicians and patients an effective option for restoring dental implants at a potentially decreased lab cost, especially in cases involving screw retention.

Clinicians who enjoy lab work may find this technique extremely cost effective and rewarding. Prospective clinical studies are needed to further document the ability of nanocomposite materials to sustain their structural integrity during long-term use as definitive implant-supported restorations.

A major clinical concern has been the effect of occlusal materials on stress distribution in implant-supported restorations. Since an osseointegrated implant provides direct contact with the supporting bone without any viscoelasticity at the bone-implant interface, stress waves or shocks applied to the implant are concentrated in the crest of the ridge. This can potentially lead to stress fractures in the bone with subsequent resorption and even ultimate loss of the implant. The incorporation of stress-dampening materials or systems in implant-supported restorations has been suggested to reduce loads on the implant.

The impact of occlusal materials on stress distribution has been extensively investigated using FEA. While some FEA studies have found that composite resin materials offered little or no improvement in peri-implant bone stress, other studies have reported moderate to significant stress reductions. Since porcelain is harder than natural dentition, unfavorable occlusal forces can result in wear faceting of the opposing dentition. An additional concern might be raised for the potential degradation of nanocomposite materials, but to date the author has not encountered any complications in this regard. The improved durability of nanocomposite materials has made them a viable option for inlay, onlay, and full-crown restoration of natural tooth abutments, as well as for restoring cracked teeth that are already compromised and are best to not withstand heavy occlusal pressures.
Practical Procedures & Aesthetic Dentistry

The concept of a screw-retained, combined abutment-crown prosthesis was first cited by Friedman in 1993, who reported a case wherein a patient lacked sufficient vertical space to accommodate a cemented crown, and did not want to compromise the adjacent dentition with a conventional fixed or removable restoration. The combination post-and-crown prosthesis effectively restored function and provided clinically acceptable aesthetics for the patient. The present technique using nanocomposite materials was developed under a similar set of circumstances, in a case where a conventional screw-retained prosthesis would not enable the clinician to access the implant screw hole from the lingual for a screw-retained restoration. This case also presented concerns that a lack of vertical access would preclude the use of a cemented crown, even over a custom-fabricated abutment. The employed technique allowed access through the facials of a maxillary central and lateral with excellent results.

The strength and high aesthetic qualities of nanocomposite materials enable the use of this restoration anywhere a screw-retained combination crown-abutment restoration is desired. In addition, the ability to repair prosthesis problems intraorally, the possibility of decreasing stress to opposing occlusion and implant, and the ability to allow for unconventional screw-hole access allowed access through the facials of a maxillary central and lateral with excellent results.

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CONTINUING EDUCATION
(CE) EXERCISE NO. 15

To submit your CE Exercise answers, please use the answer sheet found within the CE Editorial Section of this issue and complete as follows: 1) Identify the article; 2) Place an X in the appropriate box for each question of each exercise; 3) Clip answer sheet from the page and mail it to the CE Department at Montage Media Corporation. For further instructions, please refer to the CE Editorial Section.

The 10 multiple-choice questions for this Continuing Education exercise are based on the article “Single Tooth Restoration with a Screw-Retained, Combined Crown-and-Abutment Prosthesis,” by Robert N. Obradovich DMD, LLC. This article is on Pages 465-472.

1. What traditional challenges have been associated with screw-retained restorations in partially edentulous patients?
   a. Potential for increased implant-abutment joint opening and screw loosening.
   b. Potential for aesthetic and/or structural compromise of the prosthesis.
   c. Potential for marginal gaps between cast abutments and implants, often resulting in soft-tissue inflammation.
   d. All of the above are correct.

2. Which factors have greatly reduced the traditional complication of screw loosening?
   a. Screw-retained abutments and nanocomposite material.
   b. Improved hybrid composite materials and greater tolerances at the implant-abutment interface.
   c. Improved manufacturing tolerances at the implant-abutment interface and torque limits for screw tightening.
   d. Friction-fit screws and composite filler materials.

3. For what types of restorations may composite restorative materials be used?
   a. Provisional restorations.
   b. Definitive restorations.
   c. Both a and b are correct.
   d. None of the above is correct.

4. What must a working cast contain for indirect construction of a composite prosthesis?
   a. Implant replicas with their dimensions clearly labeled on the working cast.
   b. Replicas of the patient’s implants and surrounding soft tissues.
   c. Adjacent dentition with clearly identified anatomical landmarks.
   d. None of the above is correct.

5. Which two components can greatly facilitate fabrication of a screw-retained, single-tooth restoration?
   a. Composite denture tooth and adequate screw tightening.
   b. Composite denture tooth and precontoured abutment.
   c. Flowable composite material and precontoured abutment.
   d. Precontoured abutment and appropriate composite filler material.

6. What advantages between the mating geometry of the implant and abutment can a virtual “cold-weld” provide?
   a. Eliminate abutment rotational micromovements, vibration, and tipping associated with screw loosening.
   b. Shield the abutment screw from excessive occlusal forces.
   c. Transfer occlusal stresses into the body of the implant, where they are dispersed in bone.
   d. All of the above are correct.

7. What is an advantage of using a nanocomposite material technique?
   a. Nanocomposite has a wear coefficient comparable to enamel.
   b. This technique allows screw retention in situations with abnormal screw accesses.
   c. Nanocomposite absorbs the shock of occlusion better than porcelain thereby transferring less force to the implant and interface.
   d. All the above are correct.

8. What alternative components can eliminate the need for opaquing?
   a. Precontoured or custom zirconia abutment.
   b. Use of metal primer.
   c. Sandblasting the abutment head.
   d. Applying a thin coat of bone cement to the abutment head.

9. Which of the following areas is contraindicated for use of microfilled composite resins?
   a. Heavy, stress-bearing, posterior jaw locations.
   b. Any location in the highly visible “esthetic zone” of the maxillary jaw.
   c. Mandibular central incisor location.
   d. All of the above are correct.

10. What types of fillers do nanocomposite materials contain?
    a. Polyclusters of nanosilica particles fused with polymer-based resins.
    b. Nanomers and nanoclusters of primary zirconia/silica nanoparticles fused together with silane.
    c. Cross-linked nanomers infiltrated with alumina nanoparticles and silica clusters.
    d. None of the above is correct.