

EFFICIENT CORRECTION OF ENDODONTIC OBTURATION AND SINGLE-APPOINTMENT CAD/CAM RESTORATION

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Endodontic treatment, when performed with proper instrumentation, canal disinfection, and obturation can be a tremendous service to a dental patient and a key component of any restorative practice. It can be complicated by factors such as poor diagnosis, incomplete canal debridement, ineffective obturation, bacterial invasion, and insufficient restorative treatment. Retreatment or even tooth loss can occur when the canal space is not handled properly. This article demonstrates a procedure for the correction of pre-existing obturation and subsequent treatment with an all-ceramic restoration in a single visit.

Learning Objectives:

This article describes a case in which a surgical endodontic obturation correction is done to correct symptomatic teeth and single-visit, all-porcelain, custom-characterized CAD/CAM porcelain is placed. Upon reading this article, the reader should:

- Have a greater understanding of conservative apical correction for failing endodontically treated teeth with length control issues.
- Become familiar with single-appointment tooth preparation, porcelain fabrication, and color customization for using computer-designed, in-office, all-porcelain restorations.

Key Words: CAD/CAM, endodontic, obturation, all-ceramic, posterior

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Most clinicians have encountered patients that have undergone endodontic treatment, yet failed to return for the placement of the definitive coronal restoration. Worse yet is for the clinician to encounter a patient who has received quality therapy, but later experienced non-restorable decay. Coronal leakage from poorly sealed crowns or fillings can also allow bacterial invasion into the periapical spaces, thus predisposing the restoration to failure.

Following endodontic therapy, the sooner definitive restorations are placed, the greater their likelihood of success. A clinical study has indicated that there is a relationship between the amount of time that elapses between completion of therapy and complete coronal restorative coverage; survival rates were much higher when crowns were placed on teeth after 1 year than after 5 years.¹ There is also evidence that a quality coronal restoration with excellent fit and reduced coronal leakage is at least as important in the success of endodontic therapy as the quality of the endodontic obturation itself.² Some have shown that the quality of the coronal restoration may even be more important to endodontic success than the quality of the obturation.³ For many years, studies have shown that provisional restorations often show considerable bacterial leakage in just 1 week.⁴ Loss of teeth treated with long-term provisional restorations appears to be much more common than those with traditional restorations.⁵

Efficiency is always a consideration for the practice, and providing treatment in as few visits as possible is desirable for the patient. Efficiency is only a relevant goal, however, if a quality, predictable outcome can be achieved. While it is often best to take the methodical approach to ensure success, technological advancements often allow effective treatment that is both predictable and efficient. Single-appointment CAD/CAM procedures have moved well past the novelty stage and have become a mainstay in many practices today. To preserve tooth structure and provide aesthetic restorations, single-appointment porcelain fabrication and cementation can be a successful option for the treatment of many teeth.

The author's practice pursues six treatment goals as follows:

1. Alleviate patient symptoms;
2. Provide adequate apical seal;
3. Correct obturation errors;
4. Provide restorations that decrease the chance of coronal bacterial leakage;
5. Ensure aesthetics acceptable to the patient; and
6. Provide long-lasting, efficient treatment.

In consideration of these objectives, the following case demonstrates the author's correction of failed

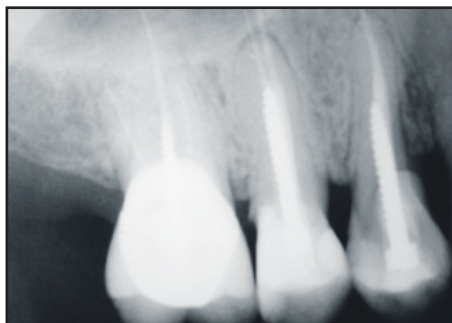


Figure 1. Obturation overfills are evident in both premolar teeth. The palatal root of the molar also seems to be overfilled but is asymptomatic.



Figure 2. Buccal view shows acceptable occlusion. A fistula was often present apical to mucogingival junction of tooth #4(15).



Figure 3. Occlusal view of leaking composite restorations and slight rotation of the teeth. This morphology was powdered and scanned.

endodontic treatment and less-than-ideal restorative techniques performed thereafter. Treatment to alleviate pain, eliminate the infection, and correct faulty restorations was accomplished in a single visit.

Case Presentation

Patient Complaint, Examination, and Treatment Plan

A 41-year-old female patient presented with aesthetic concerns regarding her maxillary right premolar teeth.



Figure 4. Reduction was performed with 2-mm rounded shoulder margins and 2 mm of occlusal clearance to help prevent fracturing.

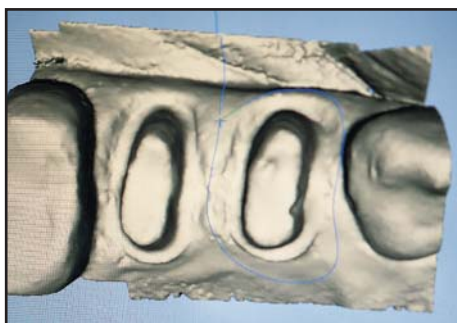


Figure 5. In the CAD design, a line was drawn to "trim the die" for accurate margin location and for interproximal contact strength.



Figure 6. Two different lines were used to copy the anatomy of the preoperative condition of the teeth in the "correlation" mode.

The patient cited as concerns both the appearance of teeth #4(15) and #5(14) at the gingival margin and an occasional "pimple" that appeared on the gingiva near the apical areas of these teeth. She had undergone endodontic therapy approximately 2 years prior and had experienced pain and tenderness in the area since then but had been told that these symptoms would improve with time. A direct composite had also been placed on the occlusal and facial surfaces to provide a temporary restoration of the teeth.

Radiograph examination revealed that previous endodontic obturation extended beyond the apex of one root on tooth #4 and two roots on tooth #5, with screw-type posts in both teeth (Figure 1). Both teeth had decay interproximally; tooth #5 also had recurrent decay. Oral examination revealed large composite restorations on the occlusal and facial surfaces (Figure 2).

Both teeth were sensitive to percussion and gave sharp pain when loading both buccal and lingual cusps with the dimpled end of a Tooth Slooth II (Professional Results, Inc., Laguna Niguel, CA).⁶ The buccal mucosa over the root surfaces of both premolars was sensitive to palpation. There was a small fibrous fistula tract near the attached and unattached tissue areas near tooth #4, but there was no major swelling or exudates at the time of examination. The unattached tissue was hyperemic and inflamed in the papilla region between the right premolar teeth.

The proposed treatment would include an apicoectomy and application of a retrograde filling material and placement of all-ceramic crowns. Although conventional endodontic retreatment was considered before surgical treatment,⁷ the long cemented screw posts and the lack of gross coronal decay required surgical endodontic correction.

Numerous all-ceramic restorations (eg, CEREC, Sirona Dental Systems, Charlotte, NC; IPS Empress, Ivoclar Vivadent, Amherst, NY; Procera, Nobel Biocare, Yorba Linda, CA) can provide durability and aesthetics in the restoration of endodontically treated teeth.⁸ Since the CEREC system provides a bonded, all-ceramic restoration in one visit, it may have potential for less coronal microleakage than traditional procedures that involve temporary restorations.⁸ There is an accepted correlation among the type of temporary material, the length of time it is used, and bacterial microleakage from the coronal part of the tooth and bacterial migration into the obturation material.^{9,10} Because the temporary phase is not needed with single-appointment porcelain, these leakage concerns are eliminated.¹¹ These benefits are particularly important in the treatment of failed endodontic teeth, where bacteria could have contributed to the reinfection of the periapical spaces.

Restorative Phase

After consultation, the patient accepted a plan of apical treatment of previous root canal therapies and all-ceramic crowns. A 90-minute appointment was scheduled, and she was placed on Clindamycin 300 mg qid for 7 days before treatment to help reduce apical infection. The patient was anesthetized with topical benzocaine, prilocaine infiltration, and an articaine injection. As the anatomy of the teeth was found to be clinically acceptable with func-

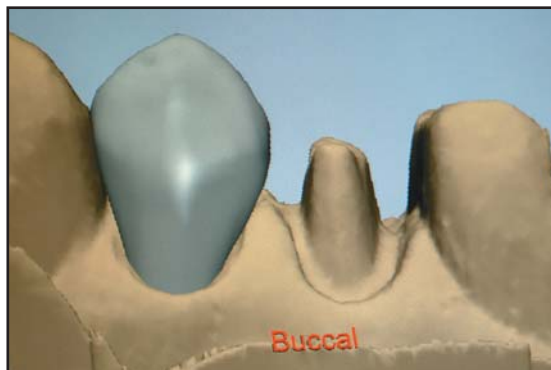


Figure 7. Proposed CAD design of the all-ceramic crown for the first premolar. Very little adjustments would be required for contouring or occlusion.



Figure 8. Excess gutta-percha and periapical granulation tissues were removed. Class I 3-mm- to 4-mm-deep retrograde preparations were then made.

tional occlusion, the “correlation” design mode of the CEREC 3D (Sirona Dental Systems, Charlotte, NC) was chosen. This mode would allow the CAD/CAM system software to closely copy the occlusal anatomy and some of the facial and lingual surfaces, which would minimize occlusal adjustments after fabrication (Figure 3). While waiting for the anesthesia to take effect, the author applied a glycerin-based powder adhesive and a titanium dioxide reflective medium from canine to molar in the affected quadrant. Three images were captured by the CAD/CAM system to provide adequate information to copy the anatomy of the unprepared teeth.

A caries indicator was applied to dry teeth several times, and all decay was removed using various burs. The defects were filled with a flowable composite resin (ie, Flow-It ALC, Pentron Corporation, Wallingford, CT). Upon access, the existing gold screw posts were found to be secure and deemed to be clinically sound. The decay on the distal aspect of the second premolar extended 3 mm subgingivally and was incorporated into the preparation.

A minimum of 2 mm of occlusal clearance in all excursive movements was prepared to provide adequate porcelain thickness and to reduce the potential of fracture (Figure 4). Using a series of course diamond burs, tooth reduction was performed. All internal line angles were rounded slightly to help decrease stresses within the porcelain. Margins were finished with an end-cutting diamond to provide a 1.5-mm rounded shoulder for strength and to facilitate recording of the margin by the CAD/CAM system. The prepared teeth were recoated with the same adhesive and titanium dioxide powder. Three images were captured by the CAD/CAM system, and a digital, three-dimensional model was created (Figure 5). The design was started with the trimming of the digital dies to ease in the porcelain design. By using the design features of the CAD/CAM system’s correlation mode, the preoperative occlusal data were

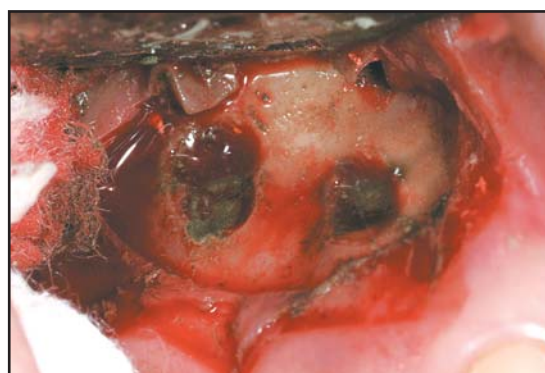


Figure 9. The MTA was placed into the retrograde preparations, and blood was allowed to pool around the MTA to help ensure set of the material.

copied into the design (Figure 6). The computer proposed a design that corrected the slight rotation of the tooth (Figure 7).

The CAD/CAM system can process several porcelain materials (eg, Vita Mark II, Vident, Brea, CA; ProCAD, Ivoclar Vivadent, Amherst, NY) that can be stained and glazed and have the strength to function in full-coverage crown restorations.^{13,14} The CAD design was finished in about 3 minutes and sent to the milling unit for the fabrication of the all-ceramic restoration. Because the entire preoperative was acquired in the CAD/CAM system, a second powdering and acquisition was not necessary. This increases efficiency as both crowns can be prepared and designed with one preoperative image and one postpreparation image. The crown being milled for the first premolar was placed on the model as a “virtual” crown so that the design could be rendered for the adjacent tooth. While milling was completed for the first premolar, the second was designed using the same principles. It was milled after milling of the first crown was completed.



Figure 10. Occlusion was verified so that the crowns were slightly out of contact. Basic anatomical occlusal grooves were then slightly accentuated with a finishing diamond bur.



Figure 12. At 6 weeks posttreatment, healing was acceptable and the patient had elimination of biting pain. The definitive all-ceramic crown restorations provide natural function and aesthetics.

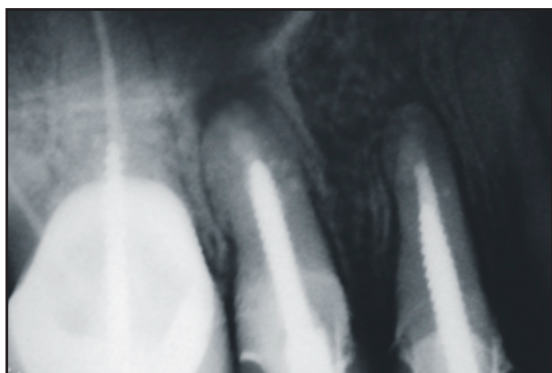


Figure 11. Radiograph taken immediately postoperation.

Surgical Endodontics

Because the total milling time for restorations of both teeth was approximately 35 minutes, the apical correction was accomplished during that time. A full-thickness flap was made across the attached tissue, and releasing incisions were made to widen the base of the incision; a periosteal elevator was used to fully reflect the tissue. Gutta-percha overfills of almost 6 mm were obvious after the reflection of soft tissue in two roots on tooth #5 and one root on tooth #4.

The end of the roots were reduced, rounded, and inspected for fractures. A 3-mm-deep Class I preparation was made into the roots along the path of the gutta-percha (Figure 8). In comparison to a shallower design, deeper preparations would provide a better apical seal against bacterial invasion.¹⁵ All granulation tissue was removed by curettes and mineral trioxide aggregate (ie, ProRoot MTA, Dentsply Tulsa, Tulsa, OK) was mixed with sterile saline into a thick paste and placed into the root preparations (Figure 9). Placement of the MTA would result in less apical leakage than other retrograde filling

materials.^{16,17} The apical preparations are dried, the material placed, and then moisture was allowed near it to facilitate setting.

Porcelain Try-In, Adjustment, and Customization

The surgical site was covered with gauze and both crowns were tried in while the MTA was setting. The margins were verified and occlusion was checked and adjusted with an extra-fine finishing diamond bur and irrigation (Figure 10). Since there was the possibility of supereruption from surgical inflammation, the teeth were left slightly out of occlusion. Final contours were finished and the crowns were removed.

The porcelain was rinsed and cleansed with alcohol to prepare for customization. Stains (ie, Vita Akzent, Vident, Brea, CA) and glaze were applied to both crowns to achieve better color match and a smooth surface to increase strength, feel for the patient, and to reduce abrasiveness for the opposing occlusion.¹⁸ A single bake was accomplished in a porcelain oven for approximately 20 minutes, and then both were bench cooled. In that time, 4-0 chromic gut sutures were used to reapproximate the tissue after excess MTA was cleaned from around the apices.

The all-ceramic crowns were then etched with hydrofluoric acid for 2 minutes, and silane was applied for 5 seconds. The crowns were cemented with a hybrid composite (ie, RelyX Unicem, 3M Espe, St. Paul, MN) and a dual-cured cement with excellent handling and wear characteristics.¹⁹ The cement was cured for 5 seconds, at which time the crowns were flossed and excess cement was removed with a 204s scaler. The crowns were then light cured for 20 seconds from three surfaces (Figures 11), and postoperative instructions were given to the patient.

Follow-up was done 3 weeks later when the



Figure 13. More than 26 months following treatment, the anatomy and function of the restorations were clinically successful.

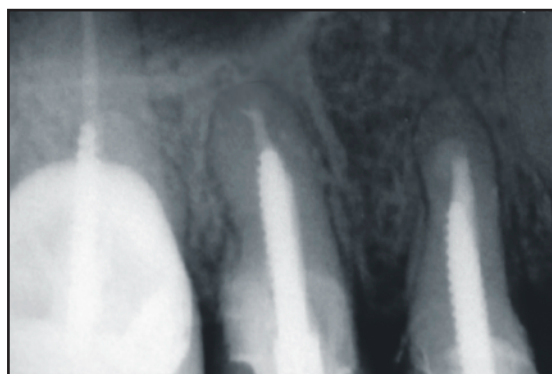


Figure 14. Radiograph at 32 months demonstrated apical healing with the absence of pathology.



Figure 15. At nearly 3 years, healing is complete and the patient is asymptomatic. Aesthetic and functional service with excellent soft tissue response has been achieved.

gingival tissues were healing well but were still slightly inflamed. At 6 weeks, healing was excellent and the patient could function comfortably on the definitive restorations (Figure 12). There was no return of a fistula or pain at the 26-month examination, and tissues were healthy with no patient complaints (Figure 13). At nearly 3 years postoperation, radiographs show a lack of periapical pathology (Figure 14); the patient had no clinical symptoms and

the function of the crowns and the soft tissue response was acceptable (Figure 15).

Conclusion

The clinician must be confident in the endodontic correction before final cementation of the all-ceramic restorations. If the apical correction had been insufficient, the patient would have been appointed for a subsequent visit or referral to an endodontist, and the patient would have been provisionalized instead of receiving the definitive crowns. In the case presented herein (despite previous endodontic failure and less-than-ideal postendodontic restorations) successful correction was achieved using techniques supported by the scientific literature. In one appointment, long-lasting, aesthetic, and health-promoting treatment was rendered, giving value to the patient and efficiency to the office.

References

1. Nagasir R, Chitmongkolsuk S. Long-term survival of endodontically treated molars without crown coverage: A retrospective cohort study. *J Prosthet Dent* 2005;93(2):164-170.
2. Aquilino SA, Caplan DJ. Relationship between crown placement and the survival of endodontically treated teeth. *J Prosthet Dent* 2002;87(3):256-263.
3. Ray HA, Trope M. Periapical status of endodontically treated teeth in relation to the technical quality of the root filling and the coronal restoration. *Int Endod J* 1995;28(1):12-18.
4. Krakow AA, de Stoppelaar JD, Gron P. In vivo study of temporary filling materials used in endodontics in anterior teeth. *Oral Surg Oral Med Oral Pathol* 1977;43(4):615-620.
5. Lynch CD, Burke FM, Ni Riordain R, Hannigan A. The influence of coronal restoration type on the survival of endodontically treated teeth. *Eur J Prosthodont Rest Dent* 2004;12(4):171-176.
6. Clinical Research Associates Newsletter. Products highly rated by CRA evaluators in clinical field trials, but not reported previously in the CRA newsletter. *CRA Newsletter* 1995;19(2):1-4.
7. Carrotte P. Surgical endodontics. *Br Dent J* 2005;198(2):71-79.
8. Naoum HJ, Chandler NP. Temporization for endodontics. *Int Endod J*;35(12):964-978.
9. Bishop K, Briggs P. Endodontic failure—A problem from top to bottom. *Br Dent J* 1995;179(1):35-36.
10. Balto H. An assessment of microbial coronal leakage of temporary filling materials in endodontically treated teeth. *J Endod* 2002;28(11):762-764.
11. Heling I, Gorfil C, Slutzky H, et al. Endodontic failure caused by inadequate restorative procedures: Review and treatment recommendations. *J Prosthet Dent* 2002;87(6):674-678.
12. CEREC Symposium 2001. *Compend Contin Educ Dent (Suppl)* 2001;22.
13. Fasbinder DJ. Restorative material options for CAD/CAM restorations. *Compend Contin Educ Dent* 2002;23(10):911-920.
14. Gaglio MA. Esthetic restorations designed with confidence and predictability. *Compend Contin Educ Dent* 2001;22 (Suppl 6):30-34.
15. Al-Kahtani A, Shostad S, Schifferle R, Bhambhani S. In-vitro evaluation of microleakage of an orthograde apical plug of mineral trioxide aggregate in permanent teeth with simulated immature apices. *J Endod* 2005;31(2):117-119.
16. Fischer EJ, Arens DE, Miller CH. Bacterial leakage of mineral trioxide aggregate as compared with zinc-free amalgam, intermediate restorative material, and Super-EBA as a root-end filling material. *J Endod* 1998;24(3):176-179.
17. Martell B, Chandler NP. Electrical and dye leakage comparison of three root-end restorative materials. *Quint Int* 2002;33(1):30-34.
18. Fischer H, Brehme M, Telle R, Marx R. Effect of ion exchange of glazed dental glass ceramics on strength parameters. *J Biomed Mater Res A* 2005;72(2):175-179.
19. Reality 2005. Houston, TX: Reality Publishing Company. 2005; 19:1004-1006.

CONTINUING EDUCATION (CE) EXERCISE No. 20

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 (CE) exercise are based on the article, "Efficient correction of endodontic obturation and single-appointment CAD/CAM restoration," by Jack D. Griffin, Jr., DMD, FAGD, PC. This article is on pages 569-574.

1. Endodontic failure can be caused by which of the following factors?
 - a. Improper diagnosis.
 - b. Poor obturation.
 - c. Poor coronal restoration.
 - d. All of the above.
2. Which of the following is the most true in terms of relationship between quality coronal restorations and long-term clinical endodontic success?
 - a. Temporaries can be left in the access indefinitely.
 - b. Complete, nonleaking coronal coverage increased the chances of endodontic success.
 - c. Thorough diagnosis, canal cleansing, and obturation yield dependable long-term success regardless of coronal therapy.
 - d. Endodontic success and restorative therapy are not related.
3. A retrograde material with proven microleakage control that is mixed with saline and placed in a moist field to stimulate material set is:
 - a. EBA.
 - b. IRM.
 - c. Amalgam.
 - d. MTA.
4. Which of the following retrograde preparations gives the least bacterial infiltration?
 - a. 1 mm to 2 mm deep.
 - b. 3 mm to 4 mm deep.
 - c. 5 mm deep or more.
 - d. None of the above.
5. Before cementing the definitive restorations on the same appointment as the endodontic therapy, the clinician should:
 - a. Have clinical experience and confidence in the outcome of the endodontic therapy.
 - b. Make sure the patient has paid in full.
 - c. Explain to the patient that the restorations should last a lifetime and should be problem-free.
 - d. Make sure the teeth are in hyperocclusion to prevent their supereruption.
6. Which of the following is an advantage of single-appointment, office-made porcelain restorations?
 - a. Better coronal seal from secondary bacterial invasion when compared to temporary restorations.
 - b. Fewer appointments with less manipulation of tissues and reduced chances of iatrogenic problems.
 - c. Quality fit, aesthetics, and function without impressions, temporaries, and additional appointments.
 - d. All of the above.
7. Which of the following is NOT a true statement?
 - a. There is evidence that suggests that a quality, nonleaking coronal restoration may be at least as important as a quality obturation.
 - b. Temporary restorations have no effect on leakage or the success of endodontic therapy.
 - c. Long-term temporary restorations yield higher endodontic failure rates than those with definitive restorations placed.
 - d. Endodontic survival rates were higher in teeth with crowns placed within 1 year of treatment over those with crowns placed at 5 years.
8. The preparation characteristics for CEREC crowns are similar to other all-porcelain systems in many ways. Which of the following is a way in which they differ?
 - a. Feather-edged margins.
 - b. Well-defined chamfer or shoulder margins.
 - c. A minimum of 1.5 mm of occlusal clearance.
 - d. Rounded, internal line angles.
9. A CAD/CAM mode that copies the occlusal morphology and some buccal and lingual anatomy and incorporates them into the milled restoration is:
 - a. Function.
 - b. Dental database.
 - c. Correlation.
 - d. Constipation.
10. Which of the following is NOT an advantage of using a self-etch composite cement?
 - a. The tooth needs to be desiccated before cementation.
 - b. No etch is necessary.
 - c. Separate bonding agents are not needed.
 - d. They may be used with all porcelain crowns.