Vital Pulp Therapy With Pulp Capping

Authored by Howard E. Strassler, DMD, and Robert Levin, DDS

Upon successful completion of this CE activity 2 CE credit hours may be awarded

A Peer-Reviewed CE Activity by DENTISTRY TODAY

Opinions expressed by CE authors are their own and may not reflect those of Dentistry Today. Mention of specific product names does not infer endorsement by Dentistry Today. Information contained in CE articles and courses is not a substitute for sound clinical judgment and accepted standards of care. Participants are urged to contact their state dental boards for continuing education requirements.
Vital Pulp Therapy With Pulp Capping

Effective Date: 11/1/2012  Expiration Date: 11/1/2015

LEARNING OBJECTIVES
After participating in this CE activity, the individual will learn:
• Clinical indications and contraindications of vital pulp therapy.
• Clinical technique for vital pulp therapy.

ABOUT THE AUTHORS

Dr. Strassler is professor and director of operative dentistry in the Department of Restorative Dentistry at the University of Maryland Dental School. He can be reached at hstrassler@umaryland.edu.

Disclosure: Dr. Strassler is a consultant for Septodont.

Dr. Levin is in private practice in Huntington Beach, Calif, for the last 25 years. He graduated from University of California, Los Angeles in 1980 with a BS in psychobiology. A 1985 graduate of University of Southern California (USC) School of Dentistry, he was clinical instructor in the Practice Dynamics, Community Dentistry within the USC School of Dentistry. He is an active member in ADA, California Dental Association, and the Orange County Dental Society. He can be reached via e-mail at treborniv@aol.com.

Disclosure: Dr. Levin has received honoraria in the past for speaking, but did not receive any compensation for writing this article.

INTRODUCTION

Vital pulp therapy is a critical aspect of all restorative treatment. The goal during the placement of any restoration, whether it be a direct placement composite resin, amalgam restoration, or a full-coverage crown, is to best maintain a vital and healthy pulp. This is accomplished with good clinical practices of caries removal, treatment of a traumatic injury to a tooth, and judicious use of air-water spray when preparing a tooth with a high-speed handpiece, among others. There are times when vital pulp therapy includes those clinical situations where the pulp is at risk due to trauma, caries, or the placement and replacement of restorations over the restorative cycle of the life of a restoration. The focus of this paper will be on vital pulp therapy as it relates to pulp capping.

Pulp capping as it is traditionally viewed refers to either indirect pulp capping or direct pulp capping. With indirect capping, some carious dentin is remaining adjacent to the pulp for a vital, symptom-free tooth. With direct capping, there is a carious exposure or a mechanical exposure of the vital pulp tissue due to trauma or a dental procedure, where the pulp is vital and asymptomatic and a therapeutic base or liner is placed to provide for maintenance of pulp vitality.

A review of the literature demonstrates that there are a variety of clinical recommendations for treatment of a carious exposed pulp for a vital permanent tooth, including endodontic therapy and pulp capping.1-6 Pulp capping is an alternative treatment to pulp extirpation, which is the standard treatment when treating an inflamed pulp.6 The American Association of Endodontists’ glossary of endodontic terms defines pulp cap as treatment of an exposed vital pulp by sealing the pulpal wound with a dental material such as calcium hydroxide or mineral trioxide aggregate (MTA) to facilitate the formation of reparative dentin and maintenance of vital pulp.7 A recent systematic review evaluated the current state of the evidence regarding clinical and radiographic success for the range of clinical treatments for vital pulp therapy, including direct pulp capping, partial pulpotomy, and full pulpotomy in vital permanent teeth with cariously exposed pulps using calcium hydroxide or MTA.3 This systematic review collected unbiased data and performed a meta-analysis of the relevant articles. This type of review is considered to provide the highest level of evidence when making recommendations for treatment.8 After a thorough analysis, this review reported success rates for vital pulp therapy as
follows: the success rate of direct pulp capping was reported as > 6 months to one year, 87.5%; > one to 2 years, 95.4%; > 2 to 3 years, 87.7%; and > 3 years, 72.9%. Partial and full pulpotomy sustained high success rates up to more than 3 years (partial pulpotomy, 99.4%; full pulpotomy, 99.3%). The conclusion of this review was that vital permanent teeth with carious pulpal exposures can be treated successfully with vital pulp therapy.

A retrospective study of direct pulp capping by dental students evaluating radiographic outcomes reviewed cases that were pulp-capped at least 3 years previously both from mechanical pulpal exposures and carious exposures. The treatment for pulpal exposures was the use of a calcium hydroxide liner for pulp capping covered with a thicker base and a definitive restorative material. The results indicated a success rate for mechanical exposures of 92.2% and for carious exposed pulps, 33.3%. Larger preparations (Class II, 56.1%) had less success than Class I preparations (83.8%). The clinical implications of this study are that direct pulp capping was recommended after mechanical exposure with immediate placement of a definitive restoration, while endodontic therapy was the choice of treatment if the pulp exposure was due to caries.

Barthel et al reported on pulp capping of carious exposures with calcium hydroxide after 5 and 10 years. Using both radiographic and pulp vitality testing, the success rate at 5 years was 37%, and at 10 years 13%. Important factors when considering pulp capping a vital tooth with a carious exposure are that the teeth exhibit minimal signs of pulpitis, have a history of being asymptomatic, and there is no radiographic evidence of periapical pathology. Success with vital pulp therapy is dependent on dentin-pulp engineering strategies using materials that have progenitor cell potentials and also interact with other nonprogenitor “supportive” cells. Under severe caries lesions, progenitor cells may be activated by growth factors released after the acidic dissolution of carious dentin. Materials recommended for pulp capping—calcium hydroxide, mineral trioxide aggregates, and bioactive tricalcium silicate—mimic these growth factors and are generally accepted for direct pulp capping of carious and noncarious pulp exposures of asymptomatic teeth.

These strategies can lead to dentin regeneration.

Before a clinician considers the placement of a direct pulp cap, the patient must understand that in most clinical situations, a carious exposure should be treated with endodontic therapy. Under the most favorable circumstances, traditional root canal treatment has a success rate of up to 95%. There are many factors that can guide the clinician in making the decision to pulp cap or not. First and foremost, the type of pulp exposure plays a critical role in the potential for success; ie, carious exposures are less successful than a mechanical or trauma injury exposing the pulp. For each clinical situation, clinical data should be collected and evaluated when making the decision to pulp cap. These data include history of pain, radiographic evaluation, pulp vitality testing data, which type of restoration is treatment planned for the tooth, if adjunctive measures will be necessary to salvage the tooth (eg, endodontic treatment, crown lengthening, a crown versus an implant), and financial considerations. The patient needs to understand what is the optimal treatment for pulp exposed teeth as compared to the alternatives. Teeth with a history of pain and a diagnosis of irreversible pulpitis should be excluded from consideration for a direct pulp cap of a carious exposure.

For those clinical situations where pulp capping is being...
considered, the clinician should evaluate specific properties of potential materials to be used for vital pulp therapies. These considerations should include handling characteristics and ease of placement, setting time, physical properties and clinical efficacy, so that the material can be easily placed on the site that needs treatment. Calcium hydroxide is the most widely used of the materials recommended for direct pulp capping. For “Portland cement” materials, the formation of calcium hydroxide is one of the bioactive components created during setting reactions with this material. The additional benefit of the alkaline chemistry of calcium hydroxide is its antimicrobial properties, which are thought to reduce or eliminate the inflammatory effects of the bacteria on the pulp. It is important to note that not all formulations of calcium hydroxide have a stimulatory effect on human pulpoblasts. From the variety of calcium hydroxide products used in clinical practice, it has been shown that certain products have unfavorable physical properties, poor compressive strength, and lack of adhesion, requiring their use in only a localized area, and they must be covered with a stronger liner or base.

Success with a pulp capping agent is influenced by the availability of calcium ions. It has been suggested that MTA and tricalcium silicate release large numbers of calcium ions during their setting reaction, which increases dentin regeneration. Clinical evaluations have demonstrated success rates with pulp capping of carious exposed teeth using calcium hydroxide, MTA, and tricalcium silicate of between 72.9% to 98%. MTA has extended working and setting times. It was introduced as being an MTA equivalent in bioactivity. The benefit of light-cured composite material is no mixing and preliminary photopolymerization to acceptable physical properties as a base material. Concern for a photopolymerized resin material in contact with the pulpal tissue relates to the fact that resinous materials never completely set. These free monomers are of concern in direct contact with pulp tissue due to potential toxic effects and can inhibit mineralization of target cells. Currently, there are no clinical trials reported with this resin-based material.

Utilizing similar chemistry to that of MTA, a bioactive tricalcium silicate (Biodentine [Septodont]) was introduced for use in vital pulp therapy for direct pulp capping, pulpotomy, and indirect pulp capping. Goldberg described the bioactivity of this material, demonstrating the formation of apatite when immersed in phosphate solution. Laurent et al described the ability of the tricalcium silicate-based cement to induce reparative dentin synthesis by modulating pulp cells to secrete transforming growth factor-beta 1 (TGF-β1) and stimulate dental pulp mineralization. Bioactive tricalcium silicate has several advantages over calcium hydroxide and MTA. The commercialized tricalcium silicate is different from the usual dental calcium silicate Portland cement materials. The manufacturing process of...
the active biosilicate technology eliminates the metal impurities seen in the Portland cement calcium silicates. The setting reaction is a hydration of tricalcium silicate, which produces a calcium silicate gel and a calcium hydroxide. In contact with phosphate ions, it creates precipitates that resemble hydroxyapatite. These precipitates from MTA and tricalcium silicate can be incorporated into root canal dentin. A comparison of the calcium and silica uptake of adjacent root canals treated with MTA versus tricalcium silicate demonstrated a greater uptake of the tricalcium silicate. Using confocal microscopy, there was an increase in the carbonate content of interfacial dentin, which suggested intertubular diffusion and mineral tags of bioactive tricalcium silicate hydration products, creating a hybrid zone. Bently et al characterized this hybrid zone as being microleakage free. Further, bioactive tricalcium silicate is faster setting than other calcium silicate cements, allowing it to be used as a liner and as a dentin substitute base under definitive restorative materials. An evaluation comparing Biodentine to 2 commercially available liner/base materials, Fuji IX (GC America) and VitreBond (3M ESPE) in their resistance to compressive deflection when covered with a restorative composite resin, demonstrated that after a 10 minute setting time all 3 materials tested supported the composite resin at a clinically relevant load.

Histologically, the bioactive tricalcium silicate demonstrated the ability to induce odontoblast differentiation from pulp progenitor cells. The resulting mineralized matrix had the molecular characteristics of dentin. An evaluation comparing the biocompatibility of Biodentine with MTA and Dycal demonstrated that Biodentine was equivalent to ProRoot MTA (DENTSPLY) and more biocompatible than Dycal (DENTSPLY Caulk). A clinical evaluation from 6 to 35 months of Biodentine as a base and for pulp capping demonstrated both biocompatibility and longevity.

In recent years, there has been a greater acceptance of practice-based research studies. These practice-based evaluations have undertaken short-term clinical studies to solve problems that are encountered in daily clinical practice. Practice-based research networks have been shown to strengthen the professional knowledge base by applying principles of good clinical practice, creating a resource for training practitioners and improving the scope of care. A practice-based study by the second author of this paper evaluated the use of a tricalcium silicate material (Biodentine) as vital pulp therapy in pulp capping of carious teeth with recalls up to 2 years; at the last recall 46 of 48 teeth were still vital and pain-free. Critical to clinical success and as part of the protocol, teeth that were asymptomatic vital permanent teeth with radiographic evidence of deep caries in proximity to the pulp, with no radiographic evidence of periapical pathology and no past history of pain, were selected for inclusion in this study.

**CASE REPORT**

A 24-year-old patient presented with a deep carious lesion on the facial surface of the mandibular canine. There was no past history of pain, and the tooth pulp tested vital to
electric pulp test (EPT) and cold test with no lingering pain. The tooth was negative to percussion and palpation. There was no radiographic evidence of periapical pathology (Figure 2). During caries removal with a spoon excavator hand instrument, a small carious pulpal exposure was visualized (Figure 3). Since there was no history of pain and the pulp was vital, the decision was made to do a direct pulp cap with a tricalcium silicate material (Biodentine). Following the clinical protocol described by Bogen et al., after caries removal, bleeding of the vital pulp was controlled using a cotton pellet wet with sodium hypochlorite, placing pressure on the pulp exposure. When the bleeding was controlled, the preparation was blotted dry with a dry cotton pellet. The tricalcium silicate was mixed as per the manufacturer’s directions. The mixed material was puttylike in consistency (Figure 4). The Biodentine was dispensed to a mixing pad and was applied to the cavity preparation using an amalgam carrier. The cavity preparation was bulk-filled and the material was adapted and contoured using a plastic filling instrument. The material was allowed to set for 10 minutes. Excess restorative material was contoured with disks (Figure 5). Based upon the most recent data, the tricalcium silicate can be placed as a liner-base, allowed to set for 5 minutes, and then the preparation restored with composite resin.

One month after placement, the tooth was evaluated for pulp vitality and tested normal to cold and EPT. The tooth was negative to percussion and palpation and had been asymptomatic. The restorative material was removed, leaving a thin liner to not disturb the pulp cap, and the adjacent premolar was also prepared (Figure 6). The preparations were then restored with an etch and rinse adhesive and nano-hybrid composite resin (Figure 7).

**CONCLUSION**

Asymptomatic, carious, vital teeth can be successfully treated with indirect pulp capping. Vital pulp therapy for mechanical and carious exposures can be accomplished with pulp capping or pulpotomy covering the vital pulp using calcium hydroxide, MTA, or a tricalcium silicate cement. The patient needs to understand that the appropriate treatment of a pulp exposure is root canal treatment. Even with initial success, the patient should also understand that the tooth is still at risk for need for endodontic treatment at a later time. Follow-up evaluations are crucial to include an evaluation of pulpal vitality, sensitivity to percussion and palpation, a patient history for any symptoms, and radiographic evaluation.

For caries-exposed vital pulps where there is already inflammation of the pulp, it is difficult to obtain a consensus on decision-making for direct pulp capping. The goal for treatment of an asymptomatic vital permanent tooth with deep caries and the potential for pulp exposure, with no radiographic evidence of periapical infection, is to maintain pulpal vitality. An indirect pulp cap is preferable.

As noted previously, there are many factors that can guide the clinician in making the decision to pulp cap or not. The patient needs to understand the implications of pulp capping. Carious exposures are less successful than a mechanical or trauma injury exposing the pulp. In some cases, the amount of tooth loss due to caries may preclude the use of a pulp cap because treatment may require other measures to restore the tooth to include crown lengthening, core buildup and crown. For some patients, the choice of extensive treatment (eg, root canal therapy, core build-up, crown) is not financially possible. Rather than extraction of the tooth, pulp capping to gain time is a reasonable choice. Teeth with a history of pain and a
diagnosis of irreversible pulpitis should be excluded from consideration for a direct pulp of a carious exposure.

Vital pulp therapy can include direct pulp capping or performing a pulpotomy and covering the root canal orifices with bioactive pulp capping materials. Success rates with calcium hydroxide, MTA, and tricalcium silicate are very promising.

REFERENCES


POST EXAMINATION INFORMATION

To receive continuing education credit for participation in this educational activity you must complete the program post examination and receive a score of 70% or better.

Traditional Completion Option:
You may fax or mail your answers with payment to Dentistry Today (see Traditional Completion Information on following page). All information requested must be provided in order to process the program for credit. Be sure to complete your “Payment,” “Personal Certification Information,” “Answers,” and “Evaluation” forms. Your exam will be graded within 72 hours of receipt. Upon successful completion of the post-exam (70% or higher), a letter of completion will be mailed to the address provided.

Online Completion Option:
Use this page to review the questions and mark your answers. Return to dentalcetoday.com and sign in. If you have not previously purchased the program, select it from the “Online Courses” listing and complete the online purchase process. Once purchased the program will be added to your User History page where a Take Exam link will be provided directly across from the program title. Select the Take Exam link, complete all the program questions and Submit your answers. An immediate grade report will be provided. Upon receiving a passing grade, complete the online evaluation form. Upon submitting the form, your Letter Of Completion will be provided immediately for printing.

General Program Information:
Online users may log in to dentalcetoday.com any time in the future to access previously purchased programs and view or print letters of completion and results.

POST EXAMINATION QUESTIONS

1. The following form of vital pulp therapy is performed when some carious dentin remains adjacent to the pulp for a vital, symptom-free tooth:
   a. Direct pulp capping.
   b. Indirect pulp capping.
   c. Partial pulpotomy.
   d. Full pulpotomy.

2. The standard treatment for an inflamed pulp is:
   a. Direct pulp capping.
   b. Indirect pulp capping.
   c. Pulp extirpation.
   d. Partial pulpotomy.

3. A systematic review of the literature reports that the success rate of direct pulp capping at > 3 years is:
   a. 72.9%.
   b. 87.5%.
   c. 95.4%.
   d. 99.4%.

4. An important factor when considering pulp capping a vital tooth with a carious pulp exposure is:
   a. The tooth exhibits minimal signs of pulpitis.
   b. The tooth has a history of being asymptomatic.
   c. There is no radiographic evidence of periapical pathology.
   d. All of the above.

5. The following material is generally accepted for direct pulp capping of carious and noncarious pulp exposures of asymptomatic teeth:
   a. Calcium hydroxide.
   b. Mineral trioxide aggregate (MTA).
   c. Bioactive tricalcium silicate.
   d. All of the above.

6. Under the most favorable circumstances traditional root canal treatment has a success rate of up to:
   a. 75%.
   b. 85%.
   c. 90%.
   d. 95%.

7. The type of pulp exposure plays a critical role in potential success. Carious exposures are more successful than a mechanical or trauma injury exposing the pulp.
   a. The first statement is true, the second is false.
   b. The first statement is false, the second is true.
   c. Both statements are true.
   d. Both statements are false.
8. Barthel et al reported a success rate of ____ for pulp capping of carious exposures with calcium hydroxide at 10 years.
   a. 15%.
   b. 37%.
   c. 42%.
   d. 58%.

9. Success with a pulp capping agent is influenced by the presence of ________ ions.
   a. Sodium.
   b. Calcium.
   c. Fluoride.
   d. Potassium.

10. Research indicates that MTA requires a setting time of ______ hours to resist displacement from dentin walls of a preparation.
    a. 2.
    b. 12.
    c. 24.
    d. 72.

11. Bioactive tricalcium silicate was introduced for use in the following:
    a. Direct pulp capping.
    b. Pulpotomy.
    c. Indirect pulp capping.
    d. All of the above.

12. When tricalcium silicate comes in contact with phosphate ions, it creates precipitates that resemble ____________:
    a. Dentin.
    b. Enamel.
    c. Hydroxyapatite.
    d. Smear layer.

13. Biodentine is faster setting than other calcium silicate cements. It may be used as a liner and as a dentin substitute base under definitive restorative materials.
    a. The first statement is true, the second is false.
    b. The first statement is false, the second is true.
    c. Both statements are true.
    d. Both statements are false.

14. Success with a pulp capping agent is influenced by the availability of calcium ions. MTA and tricalcium silicate do not release large numbers of calcium ions during their setting reaction.
    a. The first statement is true, the second is false.
    b. The first statement is false, the second is true.
    c. Both statements are true.
    d. Both statements are false.

15. The manufacturing process of active biosilicate technology eliminates the __________ seen in the “Portland cement” calcium silicates.
    a. Calcium ions.
    b. Acidity.
    c. Metal impurities.
    d. Phosphate ions.

16. Bioactive tricalcium silicate demonstrates the ability to induce odontoblast differentiation from pulp progenitor cells. The resulting mineralized matrix has the molecular characteristics of dentin.
    a. The first statement is true, the second is false.
    b. The first statement is false, the second is true.
    c. Both statements are true.
    d. Both statements are false.
PROGRAM COMPLETION INFORMATION
If you wish to purchase and complete this activity traditionally (mail or fax) rather than online, you must provide the information requested below. Please be sure to select your answers carefully and complete the evaluation information. To receive credit you must answer at least 12 of the 16 questions correctly.

Complete online at: dentalctoday.com

TRADITIONAL COMPLETION INFORMATION:
Mail or fax this completed form with payment to:

Dentistry Today
Department of Continuing Education
100 Passaic Avenue
Fairfield, NJ 07004
Fax: 973-882-3622

PAYMENT & CREDIT INFORMATION:
Examination Fee: $40.00  Credit Hours: 2.0
Note: There is a $10 surcharge to process a check drawn on any bank other than a US bank. Should you have additional questions, please contact us at (973) 882-4700.
☐ I have enclosed a check or money order.
☐ I am using a credit card.
My Credit Card information is provided below.
☐ American Express  ☐ Visa  ☐ MC  ☐ Discover
Please provide the following (please print clearly):

Exact Name on Credit Card

Credit Card #   Expiration Date

PERSONAL CERTIFICATION INFORMATION:

Last Name (PLEASE PRINT CLEARLY OR TYPE)
First Name
Profession / Credentials  License Number
Street Address
Suite or Apartment Number
City   State   Zip Code
Daytime Telephone Number With Area Code
Fax Number With Area Code
E-mail Address

PROGRAM EVALUATION FORM
Please complete the following activity evaluation questions.

Rating Scale: Excellent = 5 and Poor = 0

Course objectives were achieved. 
Content was useful and benefited your clinical practice. 
Review questions were clear and relevant to the editorial. 
Illustrations and photographs were clear and relevant. 
Written presentation was informative and concise. 
How much time did you spend reading the activity and completing the test? 

What aspect of this course was most helpful and why?

What topics interest you for future Dentistry Today CE courses?

Approved PACE Program Provider
ADA/MAGD Credit Approval does not imply acceptance by a state or provincial board of dentistry or AGD endorsement. June 1, 2013 to May 31, 2015 AGD PACE approval number: 309062

ADA CERP®

Continuing Education Recognition Program
Dentistry Today, Inc. is an ADA CERP Recognized Provider. ADA CERP is a service of the American Dental Association to assist dental professionals in identifying quality providers of continuing dental education. ADA CERP does not approve or endorse individual courses or instructors; nor does it imply acceptance of credit hours by boards of dentistry. Concerns or complaints about a CE provider may be directed to the provider or to ADA CERP at ada.org/glr/cecmp.