

Pulp Therapy for Children

by Drs. Joel Berg and Nestor Cohenca

Introduction

Pulp therapy for children is performed to preserve the health status of the tooth and its ultimate position in the arch for the expected life of the tooth. In the case of a primary tooth, that length of time for “expected life” is measured against the expected life of the tooth in the mouth without pulp disease or pulp therapy. In the case of a permanent tooth, it means long-term preservation of the tooth, in a healthy state in the mouth. This brief manuscript will review the rudiments of pulp therapy for children. It is recommended that the practitioner gather additional information in each of the referenced areas prior to engaging in pulp therapy for children. Although not always specifically mentioned, effective local anesthesia and rubber dam usage are always required.

Primary Anterior Teeth

When decay or tooth preparation extends into the pulp chamber of the primary incisor or canine, first, an assessment of the vitality of the pulp must be made. This should actually be done prior to the procedure via radiographic assessment, or by direct examination of pulp and its color, texture and bleeding during the procedure. If the pulp does not bleed at all or bleeds at a hemorrhagic level, it might be infected beyond the coronal pulp, and a pulpectomy might be in order. In this instance, the coronal and radicular pulps should be removed all the way to the apex of the tooth. The radicular pulp chamber may be filled with a resorbable paste of either zinc-oxide eugenol or, preferably, calcium hydroxide with iodoform within the paste. The paste is condensed into the radicular pulp chamber after careful

pulp extirpation, while cleaning the canal and irrigation with saline. Generally, sodium hypochlorite has not been used to clean the pulp canals of primary teeth. The coronal chamber should be filled with glass ionomer or resin-modified glass ionomer. The crown is then restored with either a stainless steel crown, a composite strip crown, or a pre-veneered, commercially available, composite-faced stainless steel crown. If there are signs of early external root resorption, radiolucency beyond the confines of the pulp chamber related to the tooth or other signs of disease, or inadequate tooth structure to support a restoration, the tooth might need to be extracted.

Primary Molars

When decay or tooth preparation extends into the coronal pulp, and the pulp is deemed vital (as described above), a pulpotomy may be performed. The entire coronal pulp is removed circumferentially with a large round bur, pulling coronally to adequately “deroof” the pulp chamber and to avoid leaving any ledges or pulp tissue therein. The radicular orifices are assessed to determine that bleeding can be controlled only by direct pressure with a damp cotton piece for a minute or two. There is some debate as to whether the remaining radicular pulp orifices should be further treated with a medicament such as formocresol or ferric sulfate. The literature and standard of care is to use one of these agents (not discussed here because of the length limitations of this article), however there appears to be a directional change in thinking toward sealing the orifices completely as the primary objective. It is likely that recommendations going forward will require sealing the orifices as the main objective here. The best sealing agents appear to be mineral trioxide aggregate (MTA) or glass ionomer. Therefore, after achieving hemostasis on the radicular pulp orifices, and after using a medicament (if desired), the orifices must be sealed with one of these agents. A material that further seals, such as glass ionomer or resin-modified glass ionomer should then be used to fill the coronal pulp chamber. A stainless steel crown is the restoration of choice after performing a primary molar pulpotomy. If the pulp tissue is non-vital or the bleeding cannot be controlled at the level of the orifice, a pulpectomy should be performed. Canals should be cleaned carefully but not significantly instrumented (primary roots are narrow and curved and there is a risk of perforation or extension beyond the apex). Canals and the pulp chamber should be filled as described above for primary anterior teeth. A stainless steel crown is then used to restore the tooth. As with a primary anterior tooth, when there



continued on page 24

is disease beyond the confines of the tooth related to the tooth, consideration for extraction must be given. However, the tooth itself is the best space maintainer and space loss in the primary molar area is a significant long-term issue for the patient. If there exists the ability to retain the tooth in the mouth via pulpectomy and careful monitoring of the tooth to reduce or eliminate local infection, while waiting for a permanent molar to erupt (in the case of second primary molar infection), so that the easier to make and better tolerated band and loop from permanent molar to primary first molar (compared with the “distal shoe” appliance) can be made, then a pulpectomy may be performed with careful monitoring as a “transitional” treatment. After such transitional treatment, the molar is extracted (upon eruption of the permanent molar) and a band and loop space maintainer is placed.

Permanent Dentition Introduction

Endodontics is defined as the branch of dentistry concerned with the morphology, physiology and pathology of the human dental pulp and periradicular tissues. However, the ultimate endodontics goal could be defined as the prevention and/or elimination of apical periodontitis. The etiology of apical periodontitis is caused by toxic metabolites and byproducts released from micro-organisms within the canal which diffuse into periapical tissues eliciting inflammatory responses and bone resorption. Thus, in clinical terms, a necrotic, infected pulp is required for apical periodontitis to be present. Conversely, if the pulp is vital there should be few or no bacteria present in the root pulp space and thus the disease (apical periodontitis) should not be present. Therefore, the preservation and treatment of the vital pulp is critical for the prevention of apical periodontitis.

Vital Pulp Therapy in Permanent Teeth

Vital pulp therapy has a high success rate if the following conditions are met: (1) the pulp is not inflamed; (2) hemorrhage is properly controlled; (3) a non-toxic capping material is applied; and (4) the capping material and restoration seal out bacteria.

Indirect Pulp Therapy (IPT)

Indirect pulp capping has been defined as a procedure in which a small amount of carious dentin is retained in deep areas of cavity preparation to avoid an exposure of the pulp. A medicament is then placed over the carious dentin to stimulate and encourage pulp recovery.

Indications:

1. Vital pulp
2. Normal radiographic findings
3. No history of spontaneous, lingering or severe pain
4. No extensive restoration or full crown requirements

Contraindications:

1. History of spontaneous pain or signs of irreversible pulpitis
2. Clinical or radiographic evidence of pulpal or periradicular pathosis
3. Carious exposure
4. Tooth requires extensive restoration or full crown

Technique:

1. Remove soft, leathery caries-affected tooth structure until dentin consistency changes or pulp exposure is imminent.
2. Disinfect the cavity using 2.5% sodium hypochlorite for at least one minute.
3. Place calcium hydroxide or glass ionomer directly over the carious region.
4. Place a permanent restoration.

On a retrospective study, Gruythuysen et al. clinically and radiographically examined the three-year survival of teeth treated with indirect pulp therapy (IPT) performed between 2000 and 2004. After placement of a layer of resin-modified glass ionomer as liner over carious dentin, the teeth were restored. Failure was defined as the presence of either a clinical symptom (pain, swelling or fistula) or radiologic abnormality at recall. The survival rate was 96 percent for primary molars (mean survival time, 146 weeks) and 93 percent for permanent teeth (mean survival time, 178 weeks). This study shows that IPT performed in primary and permanent teeth of young patients might result in a high three-year survival rate. However, other studies had given a lower prognosis to indirect pulp therapy, especially in permanent teeth. With the development of more biocompatible materials with high-sealing properties, these teeth might have a better outcome with direct pulp therapy.

Direct Pulp Therapy (DPT)

Direct pulp capping is defined as the placement of a medicament on a pulp that has been exposed in the course of excavating the last portions of deep dental caries. The rationale behind this treatment is the encouragement of young healthy pulps to initiate a dentin bridge and wall off the exposure site. A good rule of thumb limits the diameter of the exposure site to less than 1.5mm.

Indications:

1. Mechanically or traumatically exposed primary and young permanent teeth
2. No history of spontaneous or irreversible inflamed pulp
3. Vital pulp
4. Normal radiographic findings

continued on page 26

5. Controlled hemorrhage
6. Limited restorative treatment

Contraindications:

1. Spontaneous pain
2. Large carious exposures
3. Radiographic evidence of pulpal or periradicular pathosis
4. Calcifications in the pulp chamber
5. Excessive hemorrhage encountered
6. Exposures with purulent or serous exudates

Technique:

1. Remove all peripheral caries before removing the deepest caries.
2. Control the hemorrhage with a sterile cotton pellet moistened with sterile saline.
3. Disinfect the cavity using 2.5% sodium hypochlorite for at least one minute.
4. Place calcium hydroxide or mineral trioxide aggregates (MTA) directly over the exposure site; do not force it into the pulp.
5. Cover the capping material with glass ionomer and restore permanently.

When considering the capping material, current evidence in the literature has consistently demonstrated a better outcome when using MTA. Aeinehchi et al compared the use of MTA and calcium hydroxide in direct pulp capping cases using eleven pairs of third molars (20-25 years old) with pulps mechanically exposed, and capped with either MTA or CaOH₂, covered with ZOE and restored with amalgam. Teeth were extracted and then histologically evaluated at one week, two, three, four and six months. Odontoblastic layers appeared earlier, less hyperemia, inflammation and necrosis were noted, and dentinal bridges were more pronounced in the MTA-treated teeth. In a different randomized clinical study, Nair et al investigated the pulpal response to direct pulp capping in healthy human teeth with mineral trioxide aggregate (MTA) as against calcium hydroxide cement (Dycal) as control. MTA was clinically easier to use as a direct pulp-capping agent and resulted in less pulpal inflammation and more predictable hard-tissue barrier formation than Dycal. Therefore, MTA or equivalent products should be the material of choice for direct pulp capping procedures instead of hard-setting calcium hydroxide cements. From a clinical perspective, the control of the hemorrhage is critical to determine the level of pulp inflammation. In cases of persistent bleeding, partial pulpotomy might be indicated.

Vital Pulp Therapy in Immature Teeth

For cases with open apices, maintaining the vital pulp is essential for the development of the root and maturation of

the whole tooth. According to the AAE glossary, apexogenesis is defined as a vital pulp therapy procedure performed to encourage continued physiological development and formation of the root end. The term is frequently used to describe therapy performed to encourage the continuation of this process. The term "maturogenesis" was recently introduced by Weisleder and Benitez and defined as physiologic root development not restricted to the apical segment. The continued deposition of dentin occurs throughout the length of the root, providing greater strength and resistance to fracture. Patel and Cohenca also presented a case which demonstrates the use of mineral trioxide aggregate (MTA) as a direct pulp capping material for the purpose of continued maturogenesis of the root. Clinical and radiographic follow up demonstrated a vital pulp and physiologic root development in comparison with the contralateral tooth. MTA can be considered as an effective material for vital pulp therapy, with the goal of maturogenesis.

Treatment of Non-vital Immature Teeth

Apexification is defined as a method of inducing a calcified barrier in a root with an open apex or the continued apical development of an incompletely formed root in teeth with necrotic pulp.

Classic Technique Using Calcium Hydroxide

1. Remove necrotic pulpal tissue to a level 1mm short of the apical foramen. The use of negative pressure irrigation is highly recommended for safe and proper disinfection.
2. Fill root canal with calcium hydroxide and seal access.
3. Recall every six months until evidence of an apical barrier. This process can take anywhere between six to 24 months.
4. Verify barrier formation clinically before obturation with gutta percha.

Felippe et al. evaluated the influence of renewing calcium hydroxide paste on apexification and periapical healing of teeth in dogs with incomplete root formation and previously contaminated canals. Replacement of calcium hydroxide paste was not necessary for apexification to occur; however, replacement of calcium hydroxide paste significantly reduced the intensity of the inflammatory process. In young immature teeth with undeveloped roots and non-vital pulp, the conventional treatment (apexification) can take up to 18 months. Such long treatment planning might cause crown-root fracture at the cervical area (thin and weak dentinal walls), coronal leakage and re-contamination of the root canal space and dentinal tubules, lack of compliance from the patients to come to several appointments, and the failure to provide an aesthetic and final restoration of the crown.

continued on page 28

Alternative Technique Using MTA

Apexification procedures should be completed immediately after the infection control is achieved allowing us to strengthen the cervical third and to provide an immediate permanent and aesthetic restoration. In 2000, the use of MTA was suggested as a replacement of long-term apexification with calcium hydroxide. Numerous procedures and materials have been utilized to induce root-end barrier formation. In 2001, Witherspoon and Ham reported promising results when using MTA in one-visit apexification treatment of immature teeth with necrotic pulps. Moreover, the use of an intra-canal medication is not necessary when using MTA as an apical plug. Overall, the development of clinical applications of MTA has increased significantly the treatment outcome of vital and non-vital therapy.

Conclusion

Pulp therapy for children is relatively simple and quite effective as long as the proper assessment of the situation is made, and treatment is carried out in the appropriate fashion with strict adherence to the proper technique. ■

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Author Bios

Joel H. Berg, DDS, MS has been a member of the American Academy of Pediatric Dentistry (AAPD) for 25 years. He received his pediatric dentistry certificate and attended dental school at the University of Iowa. Berg is currently president-elect of the AAPD. He most recently served as vice president (2010-2011), secretary-treasurer (2009-2010) and the AAPD's District VI trustee (2006-2009). Berg is also a past president of Healthy Smiles, Healthy Children: the Foundation of the American Academy of Pediatric Dentistry. In addition to his leadership roles with the Academy, he is a diplomate of the American Board of Pediatric Dentistry, a fellow of the American College of Dentists and a fellow of the International College of Dentists. Berg is the associate dean for Hospital Affairs and chair, Department of Pediatric Dentistry, at the University of Washington School of Dentistry in Seattle. He is also the Director of Dentistry at Seattle Children's Hospital and the holder of the Lloyd and Kay Chapman Chair for Oral Health. Berg resides in Bellevue, Washington, and has two daughters, Dena and Jessica. He has lectured in more than 30 countries and enjoys studying the viticulture of Washington State and surfing in Hawaii. Berg is a national media spokesperson for the AAPD.

Dr. Nestor Cohenca received his dental degree from the National University of Asuncion, Paraguay. In 1994, he completed the endodontic program at the Hebrew University in Jerusalem *cum laude* and received the *Ino Sciaky* Best Graduate Student Award. He then served 11 years on faculty at the school while maintaining a private practice limited to endodontics. He is a diplomate of and was an examiner for the Israel Board of Endodontics and past president of the Israel Endodontic Society. From 2003 to 2005 he served as a clinical assistant professor and coordinator of trauma and sports dentistry at University of Southern California. Thereafter, Dr. Cohenca joined the University of Washington where he completed his endodontic certificate in 2008 and is currently an associate professor of endodontics and adjunct associate professor of pediatric dentistry. He serves as Director of Endodontics and Traumatology at the Center for Pediatric Dentistry and Seattle Children's Hospital. In 2010, Dr. Cohenca became a diplomate of the American Board of Endodontics and received an honorary membership to Omicron Kappa Upsilon National Dental Honor Society. As a full-time faculty member, he is active in research, teaching and lectures both national and internationally. He has published more than 45 peer-reviewed articles and serves as associate editor of the *Dental Traumatology Journal* and Board Director of the International Association of Dental Traumatology. Dr. Cohenca was one of the pioneers in the use of cone beam computed tomography in Endodontics and is considered one of the experts on this field. He is also an adjunct professor of pediatric dentistry with a strong background in dental traumatology and endo-pedo-related topics. Dr. Cohenca is fluent in Spanish, Portuguese and Hebrew. Dr. Cohenca maintains a private practice limited to endodontics in Redmond, Washington.