Guideline on Pulp Therapy for Primary and Young Permanent Teeth

Originating Committee
Clinical Affairs Committee–Pulp Therapy Subcommittee

Review Council
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Purpose

The American Academy of Pediatric Dentistry (AAPD) intends this guideline to describe the diagnosis of pulp pathosis and set forth the indications, objectives, and medications for pulp therapy in primary and young permanent teeth.

Methods

This guideline was revised based on a review of the literature and collaboration with experts. A MEDLINE search was conducted using the terms "pulpotomy", "pulpectomy", "indirect pulp treatment", "stepwise excavation", "pulp therapy", "pulp capping", "pulp exposure", "calcium hydroxide", "formocresol", "ferric sulfate", and "glass ionomer". Although this guideline reflects the cited literature and consensus of experts, more research is needed in the areas of vital and nonvital pulp treatment in primary and young permanent teeth to aid clinicians in the proper technique and medications for use.

Background

The primary objective of pulp therapy is to maintain the integrity and health of the teeth and their supporting tissues. It is desirable to attempt to maintain the vitality of the pulp of a tooth affected by caries, traumatic injury, or other causes. A tooth without a vital pulp, however, can remain clinically functional.[1]

The indications, objectives, and type of pulpal therapy depend on whether the pulp is vital or nonvital, based on the tooth's clinical diagnosis of normal pulp, reversible pulpitis, irreversible pulpitis, or necrotic pulp.[2] The clinical diagnosis is derived from:

1. an appropriate medical history;
2. an appropriate dental history, including characteristics of any pain;
3. visual evaluation;
4. if obtainable, radiograph(s) showing the apical areas and any furcation; and
5. additional tests such as palpation, percussion, and mobility evaluation.[1,3]

In permanent teeth, electric pulp tests and thermal tests may be helpful.[4] Teeth exhibiting signs and/or symptoms such as a history of spontaneous unprovoked toothache, a sinus tract, periodontal inflammation not resulting from gingivitis or periodontitis, excessive mobility not associated with trauma or exfoliation, furcation/apical radiolucency, or radiographic evidence of internal/external resorption have a clinical diagnosis of irreversible pulpitis or necrosis. These teeth are candidates for nonvital pulp treatment.[5-7]

Teeth exhibiting provoked pain of short duration—which is relieved upon the removal of the stimulus, with analgesics, or by brushing—without signs or symptoms of irreversible pulpitis, have a clinical diagnosis of reversible pulpitis and are candidates for vital pulp therapy.[8] Teeth with a normal pulp requiring pulp therapy are treated with vital pulp procedures.[8-11]

Recommendations

All relevant diagnostic information, treatment, and treatment follow-up shall be documented in the patient's record.

Any planned treatment should include consideration of:

1. the patient's medical history;
2. the value of each involved tooth in relation to the child's overall development;
3. alternatives to pulp treatment; and
4. restorability of the tooth.

When the infectious process cannot be arrested by the treatment methods included in this section, bony support cannot be regained, inadequate tooth structure remains for an appropriate restoration, or excessive pathologic root resorption exists, extraction should be considered.[1,6,7]

It is recommended that all pulp therapy be performed with rubber-dam isolation to minimize bacterial contamination of the treatment site.

This guideline is intended to recommend medicaments or procedures for pulp treatment, but the AAPD desires more research in pulp treatment to determine the best clinical choices. Pulp therapy evaluation requires periodic clinical and radiographic assessment of the treated tooth and the supporting structures.[8,12] Apexification, reimplantation of avulsions, and placement of prefabricated post and cores are not indicated for primary teeth. For endodontic procedures not included in this section, the AAPD supports the American Association of Endodontists' *Guide to Clinical Endodontics.*[13]

Primary teeth

Vital pulp therapy for primary teeth diagnosed with a normal pulp or reversible pulpitis

Protective base

A protective base is a material placed on the pulpal surface of a cavity preparation, covering exposed dentin tubules, to act as a protective barrier between the restorative material or cement and the tooth's pulp. Placement of a protective base such as calcium hydroxide or glass ionomer cement that possesses suitable physical properties and biocompatibility is at the dentist's discretion.[14,15]

Indications: In a tooth with a normal pulp, when dentin is exposed and all caries is removed during the preparation for a restoration, a protective radiopaque base may be placed between the permanent restoration and the dentin to minimize injury to the pulp, promote pulp tissue healing, or minimize postoperative sensitivity.

Objectives: A protective base is utilized to preserve the tooth's vitality, promote pulp tissue healing and tertiary dentin formation, and minimize microleakage. Adverse post-treatment clinical signs or symptoms such as sensitivity, pain, or swelling should not occur.

Indirect pulp treatment

Indirect pulp treatment is a procedure performed in a tooth with a deep carious lesion adjacent to the pulp. The caries near the pulp is left in place to avoid pulp tissue exposure and is covered with a biocompatible material. A radiopaque base such as calcium hydroxide, zinc oxide and eugenol, or glass ionomer cement[8,9,16] is placed over the remaining affected dentin to stimulate healing and repair. The tooth then is restored with a material that seals the tooth from microleakage.

Indications: Indirect pulp treatment is indicated in a primary tooth with no pulpitis[17] or with reversible pulpitis when the deepest carious dentin is not removed to avoid a pulp exposure.[8] The pulp is judged by clinical and radiographic criteria to be vital and able to heal from the carious insult.[8,9]

Objectives: The restorative material should seal completely the involved dentin from the oral environment. The tooth's vitality should be preserved. No post-treatment signs or symptoms such as sensitivity, pain, or swelling should be evident. There should be no radiographic evidence of pathologic external or internal root resorption or other pathologic changes. There should be no harm to the succedaneous tooth.

Direct pulp capping

When a small mechanical exposure of the pulp is encountered during cavity preparation or following a traumatic injury, an appropriate biocompatible radiopaque base such as calcium hydroxide may be placed in contact with the exposed pulp tissue. The tooth is restored with a material that seals the tooth from microleakage.[7]

Indications: This procedure is indicated in a primary tooth with a normal pulp following a small mechanical or traumatic exposure when conditions for a favorable response are optimal. Direct pulp capping of a carious pulp exposure in a primary tooth is not recommended.[18]

Objectives: The tooth's vitality should be maintained. No post-treatment signs or symptoms such as sensitivity, pain, or swelling should be evident. Pulp healing and reparative dentin formation should result. There should be no radiographic signs of pathologic external or internal root resorption or furcation/apical radiolucency. There should be no harm to the succedaneous tooth.

Pulpotomy

Pulpotomy is a procedure performed in a tooth with a deep carious lesion adjacent to the pulp. The coronal pulp is amputated, and the remaining vital radicular pulp tissue surface should be treated with a medicament such as formocresol[7,8] or ferric sulfate[19] or with electrocautery[11] to preserve the radicular pulp's health. The coronal pulp chamber is filled with a suitable base, and the tooth is restored with a restoration that seals the tooth from microleakage.

Indications: The pulpotomy procedure is indicated when caries removal results in pulp exposure in a primary tooth with a normal pulp or reversible pulpitis[8] or after a traumatic pulp exposure.[7] The coronal tissue is amputated, and the remaining radicular tissue is judged to be vital by clinical and/or radiographic criteria.

Objectives: The radicular pulp should remain healthy without adverse clinical signs or symptoms such as sensitivity, pain, or swelling. There should be no postoperative radiographic evidence of pathologic external or internal root resorption. There should be no harm to the succedaneous tooth.

Nonvital pulp treatment for primary teeth diagnosed with irreversible pulpitis or necrotic pulp

Pulpectomy

Pulpectomy is a root canal procedure for pulp tissue that is irreversibly infected or necrotic due to caries or trauma. The root canals are debrided, enlarged, disinfected, and filled with a resorbable material such as nonreinforced zinc oxide-eugenol.[20] The tooth then is restored with a restoration that seals the tooth from microleakage.

Indications: A pulpectomy is indicated in a primary tooth with irreversible pulpitis or necrosis or a tooth treatment planned for pulpotomy in which the radicular pulp exhibits clinical signs of pulp necrosis such as excessive hemorrhage. The roots should exhibit minimal or no resorption.

Objectives: Following treatment, the radiographic infectious process should resolve in 6 months, as evidenced by bone deposition in the pretreatment radiolucent areas, and pretreatment clinical signs and symptoms should resolve within 2 weeks. There should be radiographic evidence of successful filling without gross overextension or underfilling. The treatment should permit resorption of primary tooth root structures and filling materials at the appropriate time to permit normal eruption of the succedaneous tooth. There should be no pathologic root resorption or furcation/apical radiolucency.

Young permanent teeth

Vital pulp therapy for teeth diagnosed with a normal pulp or reversible pulpitis

Protective base

A protective base is a material placed on the pulpal surface of a cavity preparation, covering exposed dentin tubules, to act as a protective barrier between the restorative material or cement and the tooth's pulp. Placement of a protective base such as calcium hydroxide or glass ionomer cement is at the dentist's discretion.[14,15]

Indications: In a tooth with a normal pulp, when dentin is exposed and all caries is removed during the preparation for a restoration, a protective radiopaque base may be placed between the permanent restoration and the dentin to minimize pulp injury, promote pulp tissue healing, or minimize postoperative sensitivity.

Objectives: A protective base is utilized to preserve the tooth's vitality, promote pulp tissue healing and tertiary dentin formation, and minimize microleakage. Adverse post-treatment signs or symptoms such as sensitivity, pain, or swelling should not occur.

Indirect pulp treatment

Indirect pulp treatment is a procedure performed in a tooth with a deep carious lesion adjacent to the pulp. The carious dentin near the pulp is left in place to avoid pulp tissue exposure and is covered with a biocompatible material. A radiopaque base such as calcium hydroxide,[7] zinc oxide and eugenol,[16] or glass ionomer cement[7] is placed over the remaining affected dentin to stimulate healing and repair. The tooth then is restored with a material that seals the involved tooth from microleakage.

Indications: Indirect pulp treatment is indicated in a permanent tooth with a normal pulp or reversible pulpitis when the deepest carious dentin is not removed to avoid a pulp exposure. The pulp is judged by clinical and radiographic criteria to be vital and able to heal from the carious insult.[7]

Objectives: The restorative material should seal completely the involved dentin from the oral environment. The vitality of the tooth should be preserved. No post-treatment signs or symptoms such as sensitivity, pain, or swelling should be evident. There should be no radiographic evidence of internal or external root resorption or other pathologic changes. Teeth with immature roots should show continued root development and apexogenesis.

Direct pulp capping

When a small exposure of the pulp is encountered during cavity preparation, after hemorrhage control is completed, capping the exposed pulp with a material such as calcium hydroxide or mineral trioxide aggregate (MTA)[7,21,22] is indicated prior to placing a restoration that seals the tooth from microleakage.[23]

Indications: Direct pulp capping is indicated for a permanent tooth that has a small carious or mechanical exposure in a tooth with a normal pulp.[7]

Objectives: The tooth's vitality should be maintained. No post-treatment clinical signs or symptoms of sensitivity, pain, or swelling should be evident. Pulp healing and reparative dentin formation should occur. There should be no radiographic evidence of internal or external root resorption, radiolucency, abnormal calcification, or other pathologic changes. Teeth with immature roots should show continued root development and apexogenesis.

Partial pulpotomy for carious exposures

The partial pulpotomy for carious exposures is a procedure in which the inflamed pulp tissue beneath an exposure is removed to a depth of 1 to 3 mm or, in some cases, deeper to reach healthy pulp tissue. Pulpal bleeding must be controlled, and the site should be covered with calcium hydroxide[7] or MTA.[24] A restoration that seals the tooth from microleakage is placed.

Indications: A partial pulpotomy is indicated in a young permanent tooth for a small (<2 mm) carious pulp exposure in which the pulpal bleeding is controlled in 1 to 2 minutes.[25] The tooth must be vital, with a diagnosis of normal pulp or reversible pulpitis.[7]

Objectives: The remaining pulp should continue to be vital after partial pulpotomy. There should be no adverse clinical signs or symptoms such as sensitivity, pain, or swelling. There should be no radiographic sign of internal or external resorption, abnormal canal calcification, or periapical radiolucency postoperatively. Teeth having immature roots should continue normal root development and apexogenesis.

Partial pulpotomy for traumatic exposures (Cvek pulpotomy)

The partial pulpotomy for traumatic exposures is a procedure in which the inflamed pulp tissue beneath an exposure is removed to a depth of 1 to 3 mm to reach the deeper healthy tissue. Pulpal bleeding is controlled, and the site then is covered with calcium hydroxide[26] or MTA.[7,22] A restoration that seals the tooth from microleakage is placed.

Indications: This pulpotomy is indicated for a vital, traumatically exposed, young permanent tooth, especially one with an incompletely formed apex. Pulpal bleeding after removal of inflamed pulpal tissue must be controlled. Neither the time between accident and treatment nor size of exposure is critical if the inflamed superficial pulp tissue is amputated.[26,27]

Objectives: The remaining pulp should continue to be vital after partial pulpotomy. There should be no adverse clinical signs or symptoms of sensitivity, pain, or swelling. There should be no radiographic sign of internal or external resorption, abnormal canal calcification, or periapical radiolucency postoperatively. Teeth having immature roots should show continued normal root development and apexogenesis.

Apexogenesis (root formation)

Apexogenesis is a histological term that has been used to describe the result of vital pulp procedures that allow the continued physiologic development and formation of the root's apex. Formation of the apex in vital, young, permanent teeth can be accomplished by implementing the appropriate vital pulp therapy previously described in this section (ie, indirect pulp treatment, direct pulp capping, partial pulpotomy for carious exposures and traumatic exposures).

Nonvital pulp treatment

Pulpectomy (conventional root canal treatment)

Pulpectomy in permanent teeth is conventional root canal (endodontic) treatment for exposed, infected, and/or necrotic teeth to eliminate pulpal and periradicular infection. In all cases, the entire roof of the pulp chamber is removed to gain proper access to the canals and eliminate all coronal pulp tissue. Following debridement and shaping of the root canal system, obturation of the entire root canal is accomplished with a biologically acceptable, nonresorbable filling material. Obturation as close as possible to the cementodentinal junction should be accomplished with gutta percha or other filling material acceptable as described in the *Guide to Clinical Endodontics.*[13]

Indications: Pulpectomy or conventional root canal treatment is indicated for a restorable permanent tooth with irreversible pulpitis or a necrotic pulp in which the root is formed fully. For root canal-treated teeth with unresolved periradicular lesions, root canals that are not accessible from the conventional coronal approach, or calcification of the root canal space, endodontic treatment of a more specialized nature may be indicated.

Objectives: There should be evidence of a successful filling without gross overextension or underfilling in the presence of a patent canal. There should be no adverse post-treatment signs or symptoms such as prolonged sensitivity, pain, or swelling, and there should be evidence of resolution of pretreatment pathology with no further breakdown of periradicular supporting tissues clinically or radiographically.

Apexification (root end closure)

Apexification is a method of inducing root end closure of an incompletely formed nonvital permanent tooth by removing the coronal and nonvital radicular tissue just short of the root end and placing in the canal a suitable biocompatible agent such as calcium hydroxide[7] (several treatments with a fresh agent may be necessary) or MTA.[28] Once apical closure is obtained or an apical barrier is established, root canal treatment should be completed.

Indications: This procedure is indicated for nonvital permanent teeth with incompletely formed roots.

Objectives: This procedure should induce root end closure (apexification) at the apices of immature roots or an apical barrier, as evidenced by radiographic evaluation. Adverse post-treatment clinical signs or symptoms of sensitivity, pain, or swelling should not be evident. There should be no radiographic evidence of external root resorption, lateral root pathosis, or breakdown of periradicular supporting tissues during or following therapy.

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