



# Partial pulpotomy for immature permanent teeth, its present and future

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## Abstract

Traumatic or carious exposure of a vital pulp in an immature permanent tooth presents a significant clinical challenge to maintain proper vitality. Currently available procedures include direct pulp capping, complete pulpotomy and partial pulpotomy. This paper reviews the application of partial pulpotomy in immature permanent teeth and provides prognostic and technique guidance. (*Pediatr Dent* 24:29-32, 2002)

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In a mature permanent tooth with fully formed roots, an exposed pulp should be completely removed, and the root canals should be obturated permanently. However, definitive endodontic obturation in an immature tooth arrests physiologic dentin deposition, resulting in a root with a thin dentinal wall and predisposition to fracture.<sup>1</sup> Therefore, whenever pulp exposure occurs in an immature tooth with partially developed roots, it is appropriate to employ a clinical technique which preserves as much vital pulp as possible. This, in turn, enables continued physiologic dentin deposition and complete root development.

There are three techniques available for treatment of immature permanent teeth with exposed vital pulps: direct pulp capping, complete pulpotomy, and partial pulpotomy. Direct pulp capping, the placement of a wound dressing on an exposed pulp, is considered to be so unpredictable that several authors suggested that it to be removed from treatment consideration.<sup>2-5</sup>

Complete pulpotomy (also known as cervical pulpotomy)<sup>6</sup> is the removal of coronal pulp tissue and the placement of a wound dressing on the canal orifice. Complete pulpotomy will arrest dentin formation in immature permanent teeth and can result in obliteration of the root canals.<sup>7,8</sup> It should be followed by complete endodontic therapy when root development is completed.<sup>9-11</sup> Partial pulpotomy (also known as pulp curettage),<sup>12-14</sup> removal of only the outer layer of damaged and hyperemic tissue in exposed pulps, is considered to be a procedure staged between pulp capping and complete pulpotomy.<sup>6,10,12-14</sup>

Although pulp capping and complete pulpotomy classically have been used most frequently, neither has given satisfactory results.<sup>2-5, 9-11</sup> Several recent reports of the clinical application of partial pulpotomy for teeth with cariously exposed pulps and for teeth with crown-fracture exposed pulps have shown high success rates and satisfactory results, as indicated in Table 1.<sup>15-25</sup> The indications for and techniques of partial pulpotomy are described hereafter.

## Indications for permanent tooth partial pulpotomy<sup>1,5,9,14</sup>

1. Tooth has no history of spontaneous pain.
2. Tooth has acute minor pain that subsides with analgesics.
3. Tooth has no discomfort to percussion, no vestibular swelling and no mobility.
4. Radiographic examination shows normal appearance of periodontal attachment.
5. Pulp is exposed during caries removal or subsequent to recent trauma.
6. Tissue appears vital.
7. Bleeding from the pulp excision site stops with isotonic saline irrigation within 2 minutes.

## Partial pulpotomy technique<sup>1,5,9,14,20,21</sup>

Following local anesthesia, the teeth are isolated with a rubber dam. After smoothing sharp fracture edges or removing remaining carious dentin, the exposed pulp and surrounding dentin are flushed clean with isotonic saline solution. The superficial layer of the exposed pulp and the surrounding dentin are excised to a depth of about 2 mm using a

high-speed diamond bur with light touch under waterspray cooling. The surface of the remaining pulp is irrigated gently with isotonic saline until bleeding has ceased. After hemostasis, a pulpal medicament containing biologically available calcium hydroxide is applied to the wound surface (see table 1 for intrapulpal medicaments).<sup>20,21</sup>

Care should be taken to avoid a significant blood clot developing between the wound surface and the dressing medicament. Dry, sterile cotton pellets are used carefully with modest pressure to adapt the medicament to the prepared cavity and to remove excess water from the paste. The remaining coronal cavity is then restored with a material that provides a long-term hermetic seal. It is critical to avoid bacterial contamination to the pulp tissue during the procedures and to avoid any subsequent leakage following restoration.

### Discussion

Several factors influence the treatment decisions of a clinician when encountering a tooth with a pulpal exposure. The most important factor is evaluating the degree of infection and inflammation in the pulp space. Bacteria are able to spread through the pulp only following the distribution of products from an abscess or necrosis.<sup>26-30</sup> Studies show that in the pulp subjacent to a carious lesion, just prior to or soon after pulpal exposure, bacterial components cause local irreversible changes, abscesses or necrosis just beneath the exposure. The deeper remaining pulp continues to be free from significant inflammatory changes or infiltrate with inflammatory cells.

An infected pulp usually undergoes a degenerative process in a coronal to apical direction. When pulpal infection and inflammation are restricted to the coronal portion of

the pulp chamber, unaffected healthy pulp tissue remains in the deeper portion of the root canal system. Theoretically, removal of the compromised/infected tissue should lead to preservation of a remaining vital, functioning pulp. It has been shown that even a severely inflamed pulp may heal, provided that the agent inducing inflammation is removed.<sup>31-34</sup> Clearly, it is critical to determine the degree and extent of existing pulpitis.

Currently, the pulpal diagnosis is based on the extent of pulpal hemorrhages. Failure of bleeding to cease after 2 minutes of saline irrigation reveals an extensive pulpal inflammation in the working level. It suggests that either more tissue need to be removed or an extensive procedure, such as complete pulpotomy, is indicated. There is no precise clinical definition of "irreversible" pulpitis, nor are there definite clinical or biochemical predictors of either the extent of pulpitis or the capacity of an inflamed pulp to recover.<sup>35</sup> It remains desirable to develop such precise and quantitative means for definitive endodontic diagnosis.

In trauma cases, investigators report that the time between injury and treatment actually has limited influence on the outcome of partial pulpotomy.<sup>6,15</sup> Proper treatment of pulp tissue and careful case selection seems to be the key issue of a preferable outcome. Partial pulpotomy, rather than direct pulp capping or complete pulpotomy, is the treatment of choice following traumatic or carious pulp exposure in immature permanent teeth.

Animal studies have shown that the size of the pulp exposure plays a limited role in treatment decision consideration.<sup>36,37</sup> The condition of the pulp and the degree of bacterial contamination in the pulp, rather than the size of the exposure, largely determine the progress of vital pulp therapy. Pulp tissue compromised by infection and

Table 1. Studies Evaluating Partial Pulpotomy Success

Researcher(s)	Year	Condition	Sample size	Intrapulpal medicament*	Time interval	Success rate
Cvek M <sup>15</sup>	1978	Complicated crown fracture	60	A	14-60 months	96%
Cvek M and Lundberg M <sup>16</sup>	1983	Fractured crown / exposed pulp	21	A	12-95 months	100%
Demicheri RA and Goto G <sup>17</sup>	1987	Caries free dog incisors	25	B	14,30,60 days	92%
Schroder U <i>et al.</i> <sup>18</sup>	1987	Coronal pulpitis	93	C	1 year	83%
Fuks AB <i>et al.</i> <sup>2</sup>	1987	Crown fracture	63	D	6-50 months	94%
Heide S <sup>19</sup>	1991	Incomplete root	70	E	1-6 months	94%
Mejare I and Cvek M <sup>20</sup>	1993	Caries immature permanent teeth	31	A	24-140 months	93.5%
Mass E and Zilberman U <sup>21</sup>	1993	Deep caries lesion	35	D	3/6/12 months	91.4%
Fuks AB <i>et al.</i> <sup>22</sup>	1993	Exposed pulp	63	D	1/2- 4 years	94%
Fuks AB <i>et al.</i> <sup>22</sup>	1993	Exposed pulp	63	D	7 1/2 -11 years	87.5%
Ram D and Holan G <sup>23</sup>	1994	Fractured crown / exposed pulp	2	D	21 weeks	100%
Heide S and Koppang HS <sup>24</sup>	1994	Permanent monkey incisor	67	E	1 month / 6 months	86.5%
de Blanco LP <sup>25</sup>	1996	Open apices	10	E	1,2,8 years	100%
de Blanco LP <sup>25</sup>	1996	Mature apices	20	E	1,2,8 years	100%

\*Intrapulpal medicament: A. Calasept ( Scania Dental AB, Knivsta, Sweden ); B. New Calvital ( Neodental Chemical Product, Tokyo,Japan); C. Calcium hydroxide paste ( not specific ); D. Calxyl (Dental Preparation, Otto & Co., Frankfurt / Main, FRG); E. Dycal ( L. D. Caulk Co., Milford, Delaware, USA ).

inflammation must be removed to facilitate physiologic homeostasis during saline irrigation. The depth, may be a more important predictor of the outcome. The necessity for a very deep access preparation to reach healthy tissue suggests widespread infection, a clinical contraindication to vital pulp therapy.

One of the advantages of partial pulpotomy, when compared to cervical or complete pulpotomy, is the preservation of cell-rich coronal pulp tissue. This tissue possesses better healing potential and can maintain the physiologic deposition of dentin in the cervical area.

Increasing age of a patient may negatively affect clinical success. Studies have shown that in older patients, the typically more fibrous dental pulp has a reduced ability to overcome insult.<sup>9,38</sup> Bioengineered medicaments may be useful for inducing reparative dentin, thereby decreasing the patients' advancing age as a negative factor. Recombinant human osteogenic protein-1 has been shown to induce more reparative dentin formation than calcium hydroxide paste in monkey permanent teeth.<sup>39</sup>

Recently, a material called mineral trioxide aggregate (MTA) has been used as a pulp-capping material in mechanically exposed healthy pulp with favorable results in monkeys.<sup>40</sup> Although further studies are required to elucidate the use of MTA, it should be noted that, aside from calcium hydroxide, other biocompatible materials may provide alternative options for the selection of intracanal medicaments.

In addition to the selection of intracanal medicaments, the literature indicates that the healing of dental pulp after treatment is related particularly to the capacity of sealing materials to prevent leakage and bacterial invasion.<sup>41</sup> Using restorative materials with hermetic sealing ability is a prerequisite of to a successful vital pulp treatment.

No treatment should be started without a complete diagnosis. The same principle applies to the management of vital pulp lesions. The main controversy of pulp capping and complete pulpotomy is performing treatment without attempting to investigate the status of the pulp. In pulp capping, the operator assumes pulpal damage to be minimal and performs treatment without removal of any pulp tissue. In a complete pulpotomy, the operator removes all of the pulpal tissue in the chamber as if all the tissue was damaged.

Employing currently available techniques and medicaments, the partial pulpotomy technique is a worthy alternative, particularly for immature permanent teeth with exposed vital pulps. Further studies of partial pulpotomy with new biocompatible agents are indicated to evaluate whether the promising results from the treatment of immature teeth may become applicable to an adult population. The future use of biologically more accurate diagnostic techniques in combination with bioengineered medicaments should provide a new and even broader scope for this form of vital pulp therapy.

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