Treatment of Crown Fractures With Pulp Exposure in Primary Incisors

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Abstract

The treatment options of enamel dentin crown fractures with pulpal exposure in the primary dentition traditionally consist of direct pulp capping, pulpotomy, pulpectomy, or extraction. Many clinicians disagree on the most appropriate treatment, and individual preferences exist within dentistry. Partial pulpotomy, also known as the Cvek pulpotomy, is a mode of treatment which is widely used in the permanent dentition but less so in primary teeth. This conservative technique is described and its advantages over the others are presented. In addition, a report of a case with a 2-year follow-up is also included. The purposes of this article are: (1) to present the indications and contraindications of the various treatment modalities for primary incisors with complicated crown fractures; and (2) to suggest partial pulpotomy as a conservative and more appropriate approach for primary incisors with complicated crown fracture. (*Pediatr Dent*. 2003; 25:241-247)

KEYWORDS: PRIMARY INCISORS, TRAUMA, CROWN FRACTURE, PARTIAL PULPOTOMY

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Complicated crown fracture is defined as a fracture involving enamel and dentin with pulp exposure.[1] The incidence of complicated crown fractures in primary teeth ranges between 1% to 3% of all injured teeth.[2,3] The treatment options of enamel dentin crown fractures with pulpal exposure in the primary dentition traditionally consist of direct pulp capping, pulpotomy, pulpectomy, or extraction.[4-6] Many clinicians disagree on the most appropriate treatment, and individual preferences exist.[7] Many clinical guides suggest that all pulpal exposures in primary teeth are best treated with a pulpotomy or pulpectomy.[8,9] Even in cases of minutely exposed pulps, many dentists will choose formocresol pulpotomy as their treatment of choice.[10] If the child is uncooperative, extraction of the involved tooth has been suggested in the dental literature as the treatment of choice.[1]

Partial pulpotomy (PP), also known as the Cvek pulpotomy,[11] is a mode of treatment which is widely used in the permanent dentition but less so in primary teeth.[12] This conservative technique is described and its advantages over the others are presented. In addition, a report of a case with a 2-year follow-up is included.

The purposes of this article are:

1. to present the indications and contraindications of the various treatment modalities for primary incisors with complicated crown fractures;
2. to suggest partial pulpotomy (PP) as a conservative and more appropriate approach for primary incisors with complicated crown fracture.

Partial pulpotomy

Indications

1. A small and recent pulpal exposure of up to approximately 14 days in a noncarious primary incisor is an indication that a PP is needed. Although some practitioners may prefer pulp capping when the exposure is small and when it may be treated immediately after the traumatic episode,[13] in a majority of the cases PP is preferred.

2. Sufficient tooth structure is present to allow proper restoration and full coverage of the crown with a bonded resin-composite strip crown. It is essential for increased chances of success to be able to seal the exposure site and surrounding dentin from oral contaminants, fluids, and bacteria.[14]
3. PP is highly indicated in a very young tooth with a wide-open apex and very thin root dentin walls.
4. The decisive factor for selection of the PP and its success is a healthy, noninflammed and asymptomatic vital pulp. During the procedure, an operative diagnosis should be made by assessing the pulpal tissue with regard to the bleeding from the amputation site, including the color, viscosity, and ability of the tissue to achieve hemostasis.

Description of technique

The clinical procedure is described as follows:[11,15]

1. Proper patient management should be achieved with or without premedication.
2. Local anesthesia and rubber dam placement should be administered with the slit technique.[16]
3. A no. 330 tungsten bur is used to amputate the pulp close to the exposure site to a depth of 2 mm.
4. Continuous rinsing of the amputated pulp with saline will assist in achieving hemostasis without blood clot formation within 4 minutes (if hemostasis is not achieved, all the coronal tissue should be removed and a cervical pulpotomy should be performed). A dressing of calcium hydroxide (CH) paste should be placed, followed by a base/liner of glass ionomer such as Vitrebond (3M Dental Products, St. Paul, Minn).
5. The tooth is restored using a bonded resin-composite strip crown, as described in a previous paper.[17]
6. Scheduled follow-ups should be made after 1 month, 3 months, and then every 6 months. A dentin bridge will begin to form, separating the exposure site from the rest of the pulp. The bridge may be evidenced radiographically after 6 to 8 weeks in future occlusal/periapical views.

A case of PP and its 2-year follow-up are presented and illustrated in Figures 1 to 4.

Figure 1. Preoperative posttrauma radiograph of the maxillary primary incisors of a 3-year-old child, 3 hours after injury. The child had sustained a fall and subsequently fractured the left primary central incisor. Note the involvement of the right pulp horn and its exposure.

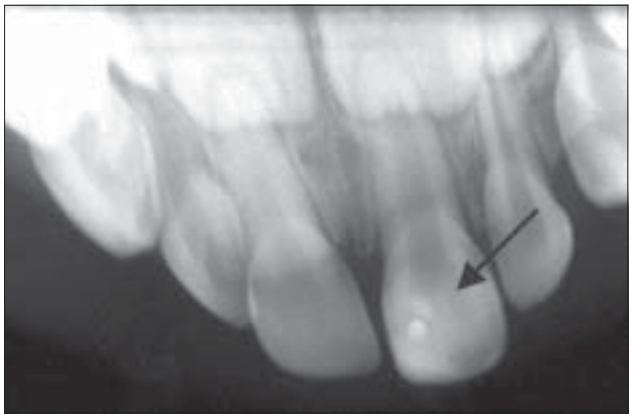

Figure 2. Three-month follow-up radiograph showing the development of a dentin bridge at the site of the partial pulpotomy.

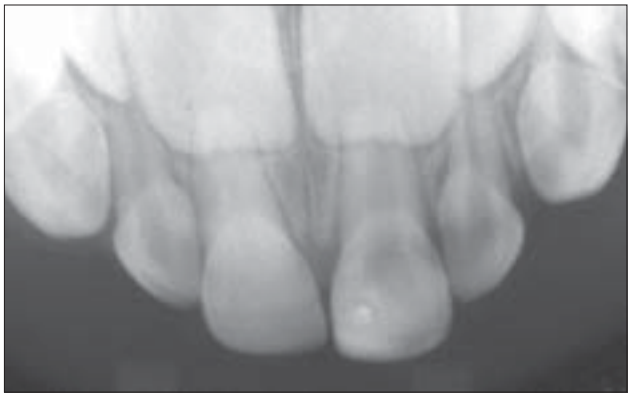

Figure 3. Two-year follow-up after the initial treatment. No pathosis or periapical areas are present in the treated tooth. Note the calcific metamorphosis of the adjacent, nontreated incisor.

Figure 4. Clinical photograph 2 years following treatment. The restored tooth appears to have retained its excellent shape and color showing good gingival health and no adverse signs.

Rationale and advantages

The PP procedure is based on the rationale that, following surgical amputation of the affected or infected pulp tissue at the exposure site, the remaining tissue is capable of healing,[11] whereas in simple capping, inflamed tissue remains at the exposure site and may interfere with pulpal healing. CH is placed above the amputation site to stimulate dentin formation, maintain vitality of the pulp, and ultimately heal the site of injury. To facilitate healing, it is essential to obtain a permanent seal against bacterial invasion from the oral cavity.

The main advantage of PP is that a successful outcome will allow the continuation of normal development of the tooth, including further root development and maturation. Apex formation and thickening of thin root walls may occur in young teeth. Older teeth will be expected to continue and undergo normal physiologic root resorption and ultimately to exfoliate naturally. Another advantage, which will be more apparent after considering the pulpectomy, is an esthetic one. The tooth following a PP will retain its natural color and translucency in comparison to the coronal discoloration many teeth undergo after pulpectomy.

Contraindications

The decisive factor for the use of PP is the assumption that the affected pulp is capable of healing after removal of its inflamed superficial layers. However, the PP cannot be recommended as yet in situations where the exposure is very large or when more than 2 weeks have passed between injury and treatment time allowing oral contaminants to cause extensive infection or inflammation beyond 2 to 3 mm of the exposure. Although individual cases may result in a favorable outcome, studies are lacking to support such treatment. In such cases, a cervical pulpotomy is the treatment of choice and will be discussed in the next section.

Cervical pulpotomy

Indications

Only after ruling out the PP should the cervical pulpotomy be considered under the following conditions:

1. The inflammation does not extend past the coronal pulp.
2. Following coronal pulp amputation, the bleeding appears normal in color, no excessive bleeding is present and good hemostasis is achieved.

Rationale and choice of pulpotomy agent

A major controversial issue regarding pulpotomy in primary incisors is the question of which agent to use when a primary pulp is treated. Formocresol (FC) has been the medicament of choice for many years. Its use is still widespread, mainly due to its high success rate.

Many dentists will not use calcium hydroxide (CH) due to the fear that it will promote internal root resorption in primary teeth (not in permanent teeth).[10] However, the clinician should take into consideration that the majority of studies showing internal resorption with the use of CH were conducted on primary molars and not on incisors.[18] A recent review paper questions the presumption that the use of CH in primary incisor teeth will cause internal resorption as has been observed in molars.[10] The authors' point of view is that CH would be more likely to cause resorption in carious molar teeth with inflamed pulps, whereas in teeth undergoing crown fracture without luxation, the pulp is expected to be relatively healthy. Following cervical pulpotomy, which includes removal of all coronal pulp, the remaining radicular pulp should be completely noninflammed. Another difference between incisors and molars is that CH would be more likely to have adverse effects in narrow pulp canals of a molar, but not in the wide and open single canal of an incisor. The authors conclude that extant inflammation amplifies CH failure, but its use may be accepted in mechanical exposures.

When using CH, the clinician should be aware that it is very important to obtain absolute hemostasis. If a blood clot forms between the CH and the pulp tissue, the blood clot may be the initiator of internal root resorption.

As mentioned previously, FC has been the most popular pulpotomy agent in primary teeth. Simply put, it works and seldom is retreatment necessary. The exact scientific mechanism of its action and effectiveness is not fully understood. FC presumably fixes affected and infected radicular pulp tissue so that a chronic inflammation replaces an acute inflammation.[10] The treated tooth is expected to remain in this state without any further root development or maturation until it is exfoliated. In contrast to CH, where the vitality of the pulp is maintained, with FC the tissue may eventually become partially or totally necrotic but still remain asymptomatic.

Due to the toxicity of FC and the assumption that CH causes internal resorption in primary teeth, other alternative agents and methods have been suggested and studied. Among the numerous agents and techniques that have been suggested are ferric sulfate, glutaraldehyde, the bone morphogenetic proteins (BMP),[10] electrocautery and the use of lasers for pulp amputation. It is not the intent nor within the scope of this paper to elaborate on these newer and as yet still experimental techniques, but the reader is encouraged to follow and look for future developments in this field. The authors would like to emphasize that the key to success, regardless of the clinician's choice of agent, is the prevention of marginal microleakage and subsequent bacterial contamination.

Description of technique

The clinical procedure of cervical pulpotomy is well known.[23] A case using formocresol as the pulpotomy agent is illustrated in Figures 5 to 7.

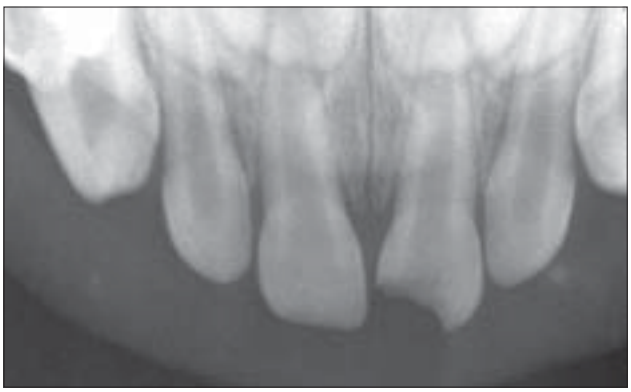

Figure 5. Occlusal radiograph immediately following trauma resulting in a complicated crown fracture with a large pulp exposure greater than 2 mm in the left central incisor. The 2-year-old child was treated under conscious sedation, and a cervical formocresol pulpotomy was performed followed by IRM placement and composite-resin strip crown.

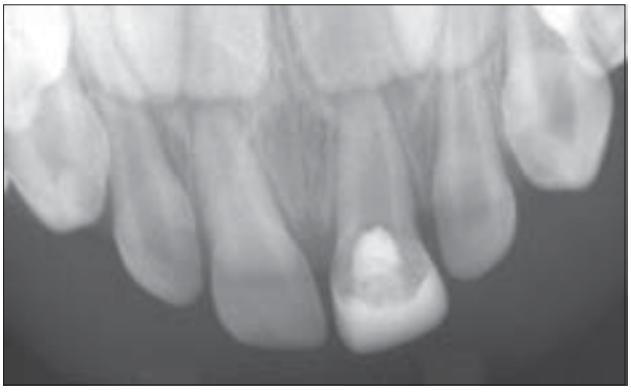

Figure 6. Radiograph exposed 18 months after treatment. Although it appears that development of the pulpotomized tooth has stopped, no pathosis or periapical areas are present.

Figure 7. Clinical photograph 18 months following treatment. A slight discoloration is present, but appearance of the restored tooth is acceptable.

Figure 8. Clinical photograph 18 months following pulpectomy of the right central incisor. An iodoform-based paste was used. Note the discoloration and unaesthetic appearance of the restored tooth. In extreme cases, the tooth undergoing pulpectomy may change its color to dark brown.

Contraindications

The pulpotomy is contraindicated when the infection of the pulps extends past the coronal section of the incisors into the canal proper. Signs and symptoms suggesting such a state include:

1. inability to achieve hemostasis after coronal pulp amputation;
2. the presence of any swelling (due to infection), fistula, or radiographic evidence of pathological periapical bone resorption.

When the criteria for cervical pulpotomy cannot be met, the next treatment alternative of pulpectomy should be considered.

Pulpectomy

Indications

1. Pulpectomy should be considered when a primary incisor is involved in trauma that has resulted in chronic inflammation or necrosis in the radicular pulp.
2. Efforts to retain the tooth by endodontic therapy should be made to maintain esthetics and function. Extraction of the involved incisor may result in space loss unless space is maintained with an appropriate appliance.

Rationale and choice of pulpectomy agent

The ideal root canal medicament for pulpectomies of primary teeth should be able to undergo resorption at a pace similar to the physiologic resorption of the primary root. If the material is expressed beyond the apex, it should be resorbed easily and nontoxic to the periapical tissues and succedaneous permanent tooth follicle. Other requirements include the ability of the material to be antiseptic, able to fill the root canals easily, and radiopaque, and not to discolor the treated tooth.[19] The most popular root canal filling materials for primary teeth are zinc oxide and eugenol, iodoform paste, and CH.[20] The former agent is far from ideal due to its resistance to undergo resorption.[21] The iodoform pastes (KRI paste, Pharmachemie, AG, CH-8053 Zürich) have been shown to produce excellent clinical results.[22] These pastes are both resorbable and have long-lasting antibacterial properties.

A recent article described the use of a CH/iodoform paste (Vitapex, Diadent Group International Inc, Bunaby, British Columbia, Canada) in root canal therapy for primary incisors.[19] The authors reported it being easy to apply due to its unique delivery system and clinically successful both clinically and radiographically, although the paste was

Figure 9. Periapical radiograph of an 18-month old child who 1 month earlier had fractured both central incisors with pulp exposure of the right incisor. Note the breakdown of the marginal bone due to the infection. The necrotic tooth underwent pulpectomy. Both incisors were restored with composite-resin strip crowns.

Figure 10. A follow-up radiograph 6 months later shows the marginal bone has regained its full height. Also note partial resorption of endodontic paste which had passed the apex during root canal filling.

resorbed from the canal. Another commercial preparation of similar composition is Endoflas (Sanlor Laboratories, Calif, Colombia, South America).

The most frustrating aspect of pulpecotmy is the presence of future discoloration in the successfully treated tooth, which may be a cause of parental dissatisfaction. The color expected after successful pulpecotmy and root canal filling with a resorbable endodontic iodoform based paste is yellow (Figure 8). In some cases, the tooth may even appear dark brown. Parents must be told before treatment that discoloration may occur, even months after treatment. Some parents may weigh the unaesthetic appearance of a severely discolored tooth and choose extraction in place of pulpectomy. Another treatment option to be considered is the use of stainless steel crowns with tooth-colored resin facings (preveneered) for teeth that had endodontic treatment, which would totally obviate the discoloration problem. Yet another disadvantage is the possibility of an ectopic eruption of the successor due to nonresorbed paste and over-retention of the primary incisor.

Technique

The classic pulpectomy technique has been described in detail in many papers and textbooks.[23] A newer method which uses nickel-titanium rotary files for root canal preparation in primary teeth has recently been recommended and described.[24]

A case using Endoflas as the pulpectomy agent is illustrated in Figures 9 and 10.

Contraindications

A pulpectomy is not recommended when:

1. an incisor exhibits extreme loss of coronal tooth structure making future restoration difficult, advanced internal and/or external root resorption, or periapical infection involving the crypt of the succedaneous tooth.[23]
2. parental concerns regarding esthetic appearance of a discolored anterior tooth.

Extraction

When the previously described treatment options are contraindicated, the treatment of last resort is the extraction of the injured tooth (Figures 11 to 12).

The clinician should consider the need for space maintenance following extraction of primary incisors. While space maintenance in the posterior region is an important consideration when there is early loss of primary molars, the anterior segment appears to be stable from canine to canine–even with the early loss of several incisors–with no net loss of space from canine to canine.[25] Occasionally, especially in a crowded dentition, if 1 or more incisors are lost, there may be some rearrangement of space between the remaining incisors, but no space maintenance is usually required if the loss occurs

Figure 11. Clinical photograph of a 27-month-old child who had sustained a complicated crown fracture that was not treated. The child appeared 6 weeks later with a parulis above the involved tooth. The tooth was extremely mobile.

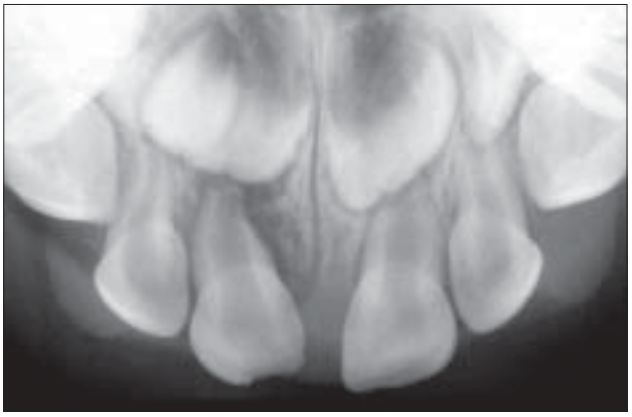

Figure 12. Periapical radiograph evidencing external root resorption, bone loss around the root of the necrotic tooth, and possible involvement of the permanent tooth follicle. The tooth was extracted.

after the eruption of the primary canines.[26] When necessary, a fixed esthetic space maintainer appliance may be placed. The clinical procedure for the fabrication and placement of anterior esthetic appliances has been described and fully illustrated elsewhere.[27] A parental concern, which usually arises, is the timing of the eruption of the permanent tooth. Parents should be advised regarding the delay or acceleration in the expected time of eruption.

Other concerns and considerations that should be conveyed to the parents before extraction include masticatory function, speech and esthetic appearance. These issues and their incorporation into proper parental counseling have also been described in detail in a previous paper.[27]

Discussion

Among the various treatment options for an injured primary incisor with complicated crown fracture, PP has the most advantages. It can be performed on both a premature and mature tooth. The procedure is quick and easy to perform. PP maintains the natural tooth color, preserves tooth structure for better retention of restoration, and is not expected to affect the permanent successor. Furthermore, when a tooth has undergone a PP, it is expected to maintain its vitality and continue its root development. Therefore, when considering the disadvantages of the pulpectomy and pulpotomy, the PP technique seems to be the treatment of choice in cases involving a small pulpal exposure with a relatively short time span between incident and treatment.

A successful PP is expressed by a dentinal bridge that forms within a few months. In young primary incisors, apex formation and thickening of dental walls should occur. No severe discoloration is expected. If obliteration of the canal occurs resulting in calcific metamorphosis, the tooth may lose its radiolucency and turn yellowish opaque, but in most cases will remain asymptomatic. Few parents will be aware of such a color change.

The downside of the PP is the lack of reports on its success. The only other report of a PP in the dental literature was made by Ram and Holan,[15] but its follow-up was only 3 months. The case presented in this paper (Figures 1 to 4) has been followed for 2 years and should be a source of encouragement for other clinicians to consider the use of this conservative treatment. More thought should be given by clinicians to preserving pulp through PP.

It is the purpose of this paper to encourage dentists to consider a new conservative approach to traumatized primary incisors. However, prospective, well-designed studies are needed to obtain the science required to accept the PP as the treatment of choice in traumatized primary incisors.

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Abstract of the Scientific Literature

Comparison between 2-point and 4-point Rapid Maxillary Expanders

Rapid maxillary expansion has been used for over 100 years to correct crossbites or expand arch perimeters to alleviate crowding. The orthopedic movements have been accomplished by including as many teeth as possible in the expansion appliance, which can be painful and difficult to seat. The purpose of this study was to determine the difference between midpalatal suture separation and dental arch perimeter expansion produced by expanders that contain 2 anchor teeth rather than 4 teeth. For this, 30 white male and female patients were enrolled in a prospective study and assigned randomly to a group that received an expander attached to the permanent first molars and first premolars or first deciduous molars or to a group that received an expander that was attached only to the permanent first molars. The screw in both appliances was the same and was turned twice a day (0.5 mm expansion/day). Patients were followed at placement of the appliance, at the end of expansion, and immediately after removal of the appliance by standardized occlusal radiographs and study models. Various measurements were made to evaluate anterior and posterior expansion, sutural expansion, and total arch perimeter expansion. The results showed that the 4-point appliance produced more anterior and posterior separation as well as an increase in arch perimeter when compared to the 2-point appliance. However, the authors state that this was not significantly different. More relapse was also found with the 2-point appliance than with the 4-point appliance.

Comments: The premise of this study is very nice. The 4-point hyrax expander is traditionally very hard to seat due to the multiple bands present in this appliance. A 2-point appliance that achieved the same results would be helpful to the practitioner. Nevertheless, in this article, the authors' figures have shown consistent differences in the amount of expansion and stability achieved by the 4-point vs the 2-point. Even with these obvious differences, the conclusions that are drawn state that there are no real differences between the 2 appliances. This seems contradictory to the results shown. Further longitudinal studies would need to be conducted to establish whether this indeed is the case before the 4-point appliance is discarded. **KV**

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