

A retrospective radiographic evaluation of primary molar pulpectomies

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Abstract

Relatively few long-term studies have been performed to evaluate the clinical success of one-appointment pulpectomies in primary molar teeth. The purpose of this retrospective study was to evaluate the radiographic appearance of nonvital primary molars before and after treatment with a one-appointment formocresol pulpectomy technique. The mean length of time since pulpectomy treatment for the 62 primary molars was 40.2 months. Based upon strict radiographic criteria, the one-appointment pulpectomy procedure was considered to be successful in 82.3% (51) of the cases, with 3.2% (2) of pulpectomized primary molars needing retreatment, and 14.5% (9) of pulpectomy procedures failing. The pulpectomy procedure is indicated when inflammation of the pulpal tissue extends into the root canals, and possibly involves the periapical and/or bifurcation areas. This procedure provides an alternative to extraction and space maintenance when the pediatric dentist encounters a nonvital primary molar tooth.

Introduction

Pulpal therapy for primary molar teeth continues to be controversial. When a primary molar has carious involvement of pulpal tissue, the dentist must assess whether the caries has progressed beyond the coronal aspect of the pulp. If no radiographic evidence exists for bony degeneration, and no apparent inflammatory reaction is occurring beyond the coronal pulp, a pulpotomy procedure may be carried out with a high degree of clinical success (Wright and Widmer 1979; Verco and Allen 1984; Hicks et al. 1986). However, if the primary molar appears to be involved more extensively, the dentist must decide whether to perform a pulpectomy or extract the tooth. The contraindications for a pulpotomy procedure are well known (Goerig and Camp 1983; Camp 1984) and include:

1. A history of spontaneous pain
2. Pain on percussion
3. Necrotic pulpal tissue
4. Suppuration from the root canals
5. Hemorrhage from pulpal tissue that cannot be controlled within 5 min after extirpation
6. Presence of a parulis or sinus tract
7. Evidence of periapical or bifurcation pathoses.

Several treatment methods have been advocated for nonvital primary molar teeth (Velling 1961; Feinglass 1973). However, these methods simply modified the pulpotomy technique, and did not attempt to either extirpate the radicular tissue or obturate the root canals. In addition to having a relatively low success rate, these procedures required multiple appointments to replenish the medicament in the pulp chamber. In contrast, Rabinowitch (1953) and Starkey (1963) advocated extirpation of pulpal tissue with instrumentation of the root canals and placement of a resorbable treatment paste. This procedure also required multiple appointments, with three to seven visits needed to complete a pulpectomy procedure. Isolated clinical case reports indicated that the pulpectomy procedure showed promise in treating necrotic pulps in primary molars (Cartwright and Bevans 1970; Starkey 1973). A preliminary clinical investigation of 35 primary molars treated with a one-appointment pulpectomy technique was completed in 1972 (Gould 1972). Despite the lack of specific evaluation criteria, the pulpectomy procedure reportedly had a clinical success rate of 82.8% after a 16-month period. Since that time, there have been few studies evaluating the pulpectomy procedure in primary molar teeth. However, a recent investigation

found that formocresol pulpectomies had a clinical success rate of more than 80% after five years (Coll et al. 1985).

The purpose of this retrospective clinical study was to determine the long-term success of the pulpectomy procedure on nonvital primary molar teeth, based upon sequential radiographic evaluation. The pulpectomy procedure was performed in a single appointment in a private pediatric practice.

Materials and Methods

Sixty-two primary molars with one-step formocresol pulpectomies performed in a pediatric dentistry practice were available for study. Only those teeth which had a pulpectomy procedure completed in a single appointment at least 12 months before the study were included. The primary indication for the pulpectomy procedure is pulpal involvement that has spread beyond the coronal aspect of the pulp, regardless of whether the pulpal tissue is vital or necrotic (Goerig and Camp 1983; Camp 1984). Primary molars with signs and symptoms such as prolonged pain, presence of pathologic sinus or parulis, limited mobility, hemorrhagic or necrotic pulpal tissue, minimal pathologic root resorption, and radiographic evidence of minimal bony degeneration were treated with the pulpectomy procedure. The pulpectomy procedure was not performed on primary molars that were nonrestorable, or when excessive root resorption and/or loss of bony support was present.

The teeth were anesthetized and isolated by rubber dam. Before the pulpectomy procedure, all caries was removed while preparing the tooth for a preformed stainless steel crown. The roof of the pulp chamber was removed with a high-speed handpiece. The coronal aspect of the pulpal tissue was amputated to the root canal orifices with a large round bur in a slow-speed handpiece. The remaining pulpal tissue occupying the root canals was removed with a series of 25 mm K-type endodontic files (Unitek Corp., Monrovia, CA) at a predetermined working length, approximately 1–2 mm short of the root apices. The canals were irrigated with water and then filled with a treatment paste consisting of a thick mixture of 1 drop of diluted formocresol, 2 parts glycerin, 1 part formocresol (Buckley's Formocresol®, Sultan Chemists, Inc., Englewood, NJ) mixed with eugenol (Healthco, Inc., Boston, MA) and zinc oxide powder (Sultan Chemists, Inc., Englewood, NJ). The prepared root canals were not exposed to formocresol before placement of the treatment paste.

The paste was introduced into the tooth with a Glick instrument, and condensed with a cotton pellet held by cotton pliers. The last file used to debride the canal then was used to carry the paste to the working length.

Additional paste was inserted into the pulp chamber as needed, and the same file was used to condense paste ahead of the file. The use of a heavy paste inserted with the largest file that engaged the canal ensured that adequate condensation had occurred. A stainless steel crown was cemented and an immediate postoperative radiograph was exposed. Before radiographic assessment, curettage of the furcation was carried out if a pathologic sinus was present. Additional radiographs were used to evaluate the success of treatment as a part of a routine recall appointment by exposing size 2 bite-wing films that showed the periapical area. Generally, films were exposed once a year unless clinical signs and/or symptoms were present.

As a group, the three authors examined the preoperative and post-treatment radiographs and reached a consensus on:

1. The presence or absence of radiolucencies in the apical and/or bifurcation areas
2. The integrity of the lamina dura
3. Whether pathologic root resorption involving the internal and/or external aspect of the tooth had occurred
4. The acceptability of the root canal filling, defined as treatment paste within 2 mm of the apex and not extending more than 1 mm beyond the apex into the adjacent periapical tissues
5. The incidence of calcific metamorphosis of the root canals
6. Whether resorption of the treatment paste had occurred
7. Whether exfoliation of the primary tooth appeared to be advanced, delayed or appropriate when compared with its antimere.

In addition, the reason for tooth loss due to extraction was classified into one of two groups, either failure of the pulpectomy technique based upon radiographic evidence, or orthodontic reasons as noted in the clinical records. After reviewing the most recent postoperative radiograph, the examiners described the treatment outcome to be successful, questionable, or a failure. The treatment outcome was judged to be successful under three conditions:

1. When the tooth had been maintained without radiographic evidence of pathologic changes
2. When there was evidence of a previously diagnosed radiolucency, but the bony lesion had decreased in size
3. When loss of integrity of the lamina dura present in the preoperative radiograph had not resolved, but no other pathoses had developed.

A failure was diagnosed when there was radiographic evidence of a new or enlarging periapical radiolucency. Questionable treatment outcomes were diagnosed when there was loss of integrity of the lamina dura that had not been observed on the preoperative radiograph.

Results

Pretreatment and post-treatment radiographs from 62 primary molar teeth treated with formocresol pulpectomies completed in one appointment were evaluated for this retrospective study (Table 1). The mean length of time since the pulpectomy procedure had been completed was 40.2 months, with post-treatment times ranging from 12 to 74 months. At the time of pulpal therapy, all teeth had completed root development.

When comparing the findings from the preoperative and post-treatment radiographs, there was a marked difference following the pulpectomy procedure (Table 2). Radiolucencies were present in 54.8% (34) of the primary molars before treatment; while only 29% (18) of the primary molars demonstrated radiolucencies on the post-treatment films. Approximately 50% (17) of the radiolucencies that were present before the pulpectomy procedure had resolved. Of those teeth that still had radiolucencies, 44.4% (8) increased in size, 22.2% (4) decreased, and 33.4% (6) remained unchanged. The lamina dura was intact in approximately 65% (40) of the

cases, whereas only 41.9% (25) of the teeth had an intact lamina dura prior to treatment. If the effects of physiologic resorption on the lamina dura in the apical and bifurcation regions of the teeth are excluded, the lamina dura would be considered to be intact in 73% (45) of the teeth before treatment, and in 76% (47) of the teeth following treatment. Pathologic root resorption was present on the pretreatment radiographs in 44% (27) of the primary molars. External resorption accounted for 62.5% (39) of the cases, with internal resorption responsible for the remaining 37.5% (23). Following the pulpectomy procedure, the percentage of primary molars with pathologic root resorption was reduced by more than one-half to 21.7% (13), with internal root resorption present in slightly more than 50% of the cases. Calcific metamorphosis, a physiological process in which the root canals were obliterated by formation of reactionary dentin, was present in 4.8% of the pulpectomized teeth. This occurred in instances of an underfilled, but acceptable, result. Because of the irregular spaces in the radicular pulp of a primary tooth, it is not possible to remove all remnants of tissue when completing a pulpectomy. Tissue may be left in the apical segment of the canal. This then will cause secondary dentin to form. This phenomenon also has been observed in 28.6% of pulpotomized primary molars (Fuks and Bimstein 1981). Histologically, dentin formation was found in all successfully treated primary monkey teeth following formocresol pulpotomies. Using tetracycline labeling, new dentin formation even was demonstrated adjacent to the treatment paste (Rolling and Melsen 1979).

The quality of the root canal obturation (Table 3) was determined to be adequate in 88.7% (55) of the pretreatment films, and in 96.8% (60) of the post-treatment films. Curettage of the furcation with a surgical curette was necessary in 8.1% of the pulpectomized molars to drain a pre-existing sinus tract that resulted from a soft tissue abscess, and to remove residual epithelium which may have undergone cystic degeneration. Retreatment was elected by the clinician in 3.2% (2) of the cases because the fill was judged to be inadequate following evaluation of the immediate post-treatment radiograph.

TABLE 1. Baseline data for posterior pulpectomies

Number of cases	62
Mean length of treatment time	40.2 months
Complete root development	100%

TABLE 2. Radiographic findings with posterior pulpectomies

	<i>Pretreatment</i>	<i>Post-treatment</i>
Radiolucency	54.8% (34)	29.0% (18)
Loss of integrity of the lamina dura	58.1 (36)	35.5 (22)
Pathologic root resorption	44.0 (27)	21.7 (13)
External	27.5 (17)	10.4 (6)
Internal	16.5 (10)	11.3 (7)
Calcific metamorphosis	0 (0)	4.8 (3)
Treatment paste resorption		88.7% (55)

TABLE 3. Evaluation of root canal obturation in posterior pulpectomies

	<i>Treatment Evaluation (immediate)</i>	<i>Post-treatment Evaluation</i>
Acceptable Fill	88.7% (55)	96.8% (60)
Curettage Necessary	8.1% (5)	0% (0)
Retreatment	3.2% (2)	3.2% (2)

The reasons for tooth loss were classified as due to either exfoliation or extraction secondary to orthodontic reasons, or pulpectomy failure (Table 4). Exfoliation occurred with 37.1% (23) of the pulpectomized molars and accounted for approximately 60% of tooth losses. When exfoliation times of the treated teeth were compared with their antimeres, advanced exfoliation was present in 56% (31) of the cases. Appropriate exfoliation time occurred with 44% (27) of the pulpectomized primary molars. No cases of delayed exfoliation were observed. Almost 25% (15) of the pulpectomized primary molars were extracted for orthodontic reasons or pulpectomy failure. Orthodontic reasons for extraction accounted for 40% (6) of the teeth extracted. Pulpectomy failure resulting in tooth extraction occurred in 14.5% (9) of the cases.

Based upon the most recent radiographs of the pulpectomized primary molars, the treatment outcomes were considered successful in 82.3% (51) of the cases (Table 5). Failure of the pulpectomy procedure occurred in 14.5% (9) of the treated primary molars. Retreatment of the pulpectomized molars, based upon radiographic evidence, appeared to be necessary with 3.2% (2) of the teeth. No questionable radiographic outcomes were diagnosed.

Discussion

Preservation of an intact primary dentition until eruption of the permanent successors is very important in maintaining the arch form. In the case of a primary tooth that has suffered pulpal insult because of trauma or dental caries, retention of the pulpally involved tooth may preserve the arch space if normal function can be restored and resolution of the pathologic process can be

achieved. In addition to preserving the arch form, utilization of pulpal therapy to maintain the integrity of the primary dentition may:

1. Allow for preservation of a pulpally involved primary tooth when the permanent successor is congenitally missing
2. Prevent aberrant tongue habits
3. Prevent possible speech problems
4. Maintain normal masticatory function
5. Preserve esthetics (Goerig and Camp 1983; Camp 1984; Hicks et al. 1986).

Recent clinical studies have shown that a relatively high success rate may be accomplished with formocresol pulpotomies and pulpectomies in both anterior and posterior primary teeth (Verco and Allen 1984; Coll et al. 1985; 1988; Hicks et al. 1986; Flaitz et al. 1989). The clinical success rates for anterior pulpotomies and pulpectomies range from 72 to 86.3% (Coll et al. 1988; Flaitz et al. 1989), whereas posterior primary molars may be treated successfully in more than 90% of cases with pulpotomies (Verco and Allen 1984; Hicks et al. 1986) and in more than 80% of cases with pulpectomies (Gould 1972; Coll et al. 1985). Within the present study, the success rate based upon radiographic evaluations was found to be 82.3% (51) with a mean treatment length of 40.2 months. Typically, the success rate for pulpal therapy has been found to be reduced by approximately 6% when radiographic criteria for success are used, as compared to clinical criteria for success (Verco and Allen 1984).

This study employed a one-appointment pulpectomy. The literature varies between one-step (Goerig and Camp 1983; Coll et al. 1985) and a two or more appointment technique (Camp 1984; Goodman 1985) with the same degree of success for both methods. For the clinician as well as the patient, a one-appointment pulpectomy is more efficient. When the procedure is planned as part of a definitive restorative visit, the one-appointment technique allows the practitioner to place the stainless steel crown immediately after the endodontic therapy.

In this study, 88.7% (55) of the root canal obturations were judged to be acceptable. At the time of the post-treatment evaluation, the number of acceptable fills had increased to 96.8% (60). In the case of primary molars that were underfilled slightly with treatment paste, this may be due to the effects of physiologic root resorption. It also may be due to the resorbable nature of the treatment paste with those primary molars that were overfilled slightly. The ability of the periapical tissue to resorb the treatment paste is evident, since almost 90% (56) of the cases the paste was undergoing resorption.

TABLE 4. Tooth loss following posterior pulpectomy therapy

<i>Reason for Tooth Loss</i>	
Extraction	24.2% (15)
Pulpectomy Failure	14.5% (9)
Orthodontic Reasons	9.7% (6)
Exfoliation	37.1% (23)
Advanced Exfoliation	21.0% (13)
Appropriate Exfoliation Time	16.1% (10)
Delayed Exfoliation	0% (0)

TABLE 5. Radiographic status of posterior pulpectomies at final evaluation

Successful	82.3% (51)
Questionable	0% (0)
Failure	14.5% (9)
Retreatment Necessary	3.2% (2)

In the present study, a number of these treated primary molars were followed radiographically until exfoliation or extraction occurred. The major reasons for tooth loss, in descending order, were exfoliation, extraction due to failure of the pulpectomy, and extraction for orthodontic reasons. While approximately 15% (9) of the primary molars were lost to pulpectomy failure, exfoliation and extraction for orthodontic reasons accounted for the loss of 46.8% (29) of the primary molars in this study. In the case of exfoliation, it was found that more than one-half of the primary molars were shed earlier than their untreated antimeres. No pulpectomized primary molars experienced delayed exfoliation. Acceleration of the process of external root resorption with formocresol pulpotomy treatment in primary teeth has been a common finding in previously reported clinical studies (Morawa et al. 1975; Wright and Widmer 1979; Fuks and Bimstein 1981). It is thought that external root resorption may start earlier than normal due to the irritating nature of formocresol. The formocresol from the treated teeth leaches into the surrounding periapical tissue, and may result in accelerated root resorption due to a chronic inflammatory reaction (Obersztyn 1963; Fuks and Bimstein 1981).

A significant concern is the effect of retaining a primary molar with previous pulpal involvement in close proximity to the succedaneous tooth. Clinicians are concerned about the possibility of recurrence of bony inflammation, the effect of formocresol on the developing succedaneous tooth, and the potential for retention of the treatment paste. In recent clinical studies (Rolling and Poulsen 1978; van Amerongen et al. 1986; Mulder et al. 1987), the influence of formocresol pulpal therapy on the permanent successors has been evaluated and compared with contralateral teeth that were not exposed to the influences of a pulpally treated primary tooth. The conclusions from these studies indicated that no significant differences were found between contralateral permanent teeth with respect to enamel opacities or hypoplasias regardless of whether or not the permanent tooth had succeeded a pulpally treated primary molar.

The results from this retrospective radiographic study of primary molars treated with a one-appointment, formocresol pulpectomy technique indicate that:

1. The pulpectomy procedure may provide an alternative to tooth extraction and space maintenance when significant involvement of the pulpal tissue and/or adjacent periodontal supporting tissue has occurred.
2. Posterior pulpectomies have a relatively high success rate, based upon radiographic criteria. With posterior pulpotomies, success rates of

greater than 90% are expected. However, with posterior pulpectomies, the success rate in the present study was found to be 82.3%. One would expect that the success rate for pulpectomies would be somewhat lower than that for pulpotomies because the degree of pathoses that is present in both the pulpal tissue and surrounding supporting structures is considerably greater for those teeth in need of a pulpectomy procedure. When one considers that the alternative to pulpectomy treatment is extraction, a success rate of greater than 80% is quite remarkable.

3. Periodic radiographic evaluation following pulpal therapy is important to determine whether or not resolution of the inflammatory process is occurring in the osseous structures, to avoid an insult to the developing permanent tooth bud when failure occurs, and to monitor the resorption of the treatment paste.

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Alternative hygienist training program subject of ongoing debate

Preceptorship, an alternative method of training dental hygienists, has been the subject of debate among many dental professionals and organized dental groups, according to a report in *AGD Impact*, published by the Academy of General Dentistry.

Under a preceptorship program, the dentist acts as a teacher ("preceptor") and provides on-the-job training to allow a dental assistant to become a dental hygienist without completing an accredited program of study.

Advocates believe that adoption of this less rigid and less costly alternative would give hygienists an opportunity to receive training while working full-time. They say preceptorship would help alleviate the perceived hygiene shortage.

The American Dental Association Commission on Dental Accreditation and the American Dental Hygienists Association (ADHA), however, oppose preceptorship programs. They argue that the hygiene shortage is not threatening enough to warrant the adoption of preceptor programs, because a study by the U.S. Bureau of Labor Statistics indicates that a sufficient supply of dental hygienists is evident to meet the current and projected demands of the public. Both groups say preceptorship lowers dental hygiene standards.

"When you look at a proposal to lower educational standards, shorten the educational program and create a technique-oriented individual, you have to sit back and think, 'What's wrong with this picture?'" says Joann Gurenlian, RDH, president of the ADHA. "Why would anybody who is a responsible health care provider be making that kind of suggestion, at a time when health care is so complex and will only become more so?"

Dental professionals in Alabama, however, have found much success with their preceptor-type Alabama Dental Hygiene Program (ADHP), the first of its kind. The program requires that students take 165 classroom hours at the University of Alabama School of Dentistry, and receive additional training in a dental office under the supervision of a sponsoring dentist. The program graduates approximately 135 dental hygienists each year.

"I chose the ADHP because I could work while I was going to school," says Jewell Wray, RDH, of Montgomery, AL, a 1985 graduate of the program. "Clinically, I'm cleaning people's teeth as well as hygienists with a formal degree. It really doesn't have anything to do with how many years a hygienist has gone to school. It has to do with experience."

As long as states consider instituting preceptorship programs, the debate probably will continue.