

Primary tooth pulp therapy as taught in predoctoral pediatric dental programs in the United States

Robert E. Primosch, DDS, MS, MEd Timothy A. Glomb, DMD R. G. Jerrell, DDS

Abstract

A survey of all predoctoral pediatric dental programs in the United States was conducted to ascertain the contemporary teaching philosophies and techniques for pulp therapy in primary teeth. All 53 predoctoral programs responded to a two-part survey consisting of multiple choice questions regarding which pulp therapies and specific techniques were taught and which pulp therapies would be employed under certain hypothetical clinical scenarios. The results of the survey confirmed some lack of consensus on the selection and application of certain treatment modalities and techniques taught for primary tooth pulp therapy in predoctoral dental programs in the United States. (Pediatr Dent 19:118–22, 1997)

It has been more than 25 years since U.S. predoctoral pediatric dental programs were polled to ascertain what was being taught regarding pulp therapy for primary teeth. Since Spedding¹ undertook that task in the 1960s, there has been no formal process of documenting contemporary teaching in this subject area. The current literature and textbooks in pediatric dentistry reveal a lack of consensus on the standard of care in primary tooth pulp therapy.

There is no one source that can claim authority regarding the philosophy and technique for primary tooth pulp therapy. The American Academy of Pediatric Dentistry has published guidelines² on this subject, but it establishes broad parameters for a wide spectrum of possible treatments. The dental literature is even more diverse and perplexing. Authors of review articles, as well as textbooks used to teach predoctoral dental students, offer varying conclusions on what are the best treatment modalities for the primary tooth pulp tissue. Some of these differing views follow.

Kopel³ supported the use of direct pulp capping on primary teeth when rigid criteria were applied for case selection. The appeal of direct pulp capping in primary teeth was tainted, however, by the higher success rates reported for other vital pulp treatments. Fuks⁴ stated that direct pulp capping for a carious exposure in primary teeth was not recommended but the higher success rate for indirect pulp treatment warranted its application in vital primary teeth. Mathewson and

Primosch⁵ did not endorse the routine application of direct or indirect pulp treatments for primary teeth. McDonald and Avery⁶ supported the use of both direct and indirect pulp treatments but did not discriminate between their use in primary or permanent teeth.

Avram and Pulver⁷ reported that the preference for formocresol as a pulpotomy medicament for vital primary teeth enjoyed worldwide popularity. Ranly and Garcia-Godoy⁸, however, recommended glutaraldehyde over formocresol as the best pulpotomy medicament. Moreover, Ranly⁹ stated that the 5-min application of formocresol in a pulpotomy has digressed from Sweet's initial intention and is now performed solely for its high success rate. He further claimed that any dilution of formocresol used is merely an extension of this empirical approach, even though a 1:5 dilution has been strongly recommended by others.^{5, 6, 10} For nonvital primary teeth, zinc oxide-eugenol (ZOE) paste is viewed as the traditional root canal filling material.⁴⁻⁶ Holan and Fuks¹¹ presented evidence that an iodoform paste was superior to the commonly used ZOE paste for an obturant in pulpectomy procedures.

These examples were but a few of the varied opinions that exist on this topic and illustrate the potential for a lack of uniformity in what is being taught to predoctoral dental students. In light of these continuing controversies, it seemed prudent to survey predoctoral pediatric dental programs in United States. The purpose of this study was to survey the contemporary philosophies and techniques of primary tooth pulp therapy being taught to predoctoral dental students. It was not the goal of this report to draw conclusions from the survey that would support a recommended standard of care for primary tooth pulp therapy. Instead we hope that educators will review these data and seek opportunities to improve curricula, evaluate techniques, and direct research to unify and improve the quality of pulp therapy delivered to the pediatric dental patient.

Materials and methods

A survey was mailed to the chairpersons of the pediatric dentistry departments of all 53 dental schools in the United States. An enclosed cover letter explained

the purpose of the survey. Chairpersons were asked to either complete the survey themselves or delegate the task to the faculty member most responsible for teaching primary tooth pulp therapy in their predoctoral curriculum. The instructions asked that the respondents put aside personal opinion and answer the questions only according to the existing departmental philosophy for pulp therapy in primary teeth. There were no specific instructions to limit responses to one best answer. This directive was purposely omitted to allow respondents to report a perceived lack of philosophical consensus, should one exist in a program's curricula. The respondents were asked to return the survey in a pre-addressed, stamped envelope.

The survey consisted of 24 multiple choice questions, divided into two sections. The first section established what therapies were taught in the department, with follow-up questions concerning specific techniques. Where appropriate, a response entitled "other" with a fill-in-the-blank was provided to allow respondents to include other selections not considered by the authors of the survey. The second section presented hypothetical clinical case scenarios in which the respondent was asked how a student would be advised to treat the patient according to existing departmental guidelines and teachings.

Results

All 53 predoctoral programs in pediatric dentistry in the United States responded to the survey, yielding a 100% response rate. The results are reported as a percent distribution of responses to each question asked. Percent response (with the raw number ratio provided in the adjacent parentheses) is located to the left of the selected response. In some cases, respondents selected more than one response which resulted in the various combinations presented. Only programs that indicated they taught a particular pulp therapy procedure were included in the percentage calculations for the specific technique questions regarding that procedure. The selected responses were rank-ordered (from highest to lowest) in this report to assist in reviewing the data, and therefore do not reflect the actual order presented in the survey. All questions, however, are presented exactly as they were stated on the survey instrument. The respondents were asked to use the definitions provided when selecting their responses.

Discussion

Indirect/direct pulp treatment

Approximately 70% of the educators surveyed indicated that they taught indirect pulp therapy for primary teeth in their predoctoral curriculum. There was a clear preference among the respondents for calcium hydroxide as the base of choice for indirect pulp treatment. When the literature was consulted, most authors cited a preference for calcium hydroxide. Some respondents selected zinc oxide-eugenol (ZOE) as the base of choice but may have misinterpreted the term "base" in

the AAPD guidelines, which was likely intended to mean "liner" rather than "base".

The respondents, however, were almost evenly split on the issue of reentering a tooth treated with an indirect pulp treatment. Some authors stated that the tooth should be reentered, but the criteria for reentry were somewhat sketchy. Camp¹⁰ reported high success rates for indirect pulp capping, but was ambiguous on whether or not the tooth should be re-entered for definitive treatment. He believed that if the tooth was within 2 years of exfoliation, retreatment was unnecessary. McDonald and Avery⁶ based the decision to reenter upon the experience level of the clinician. The fact that more than half of the dental schools did not teach re-entry may be anecdotal support for a re-examination of the conventional two-step therapy. Only 26% of respondents chose indirect pulp treatment as the treatment of choice (case A-1), even though almost 70% claimed to teach the procedure. The vast majority (74%) opted for a more aggressive approach that would culminate in a pulpotomy procedure.

In contrast, direct pulp capping followed a more uniform consistency between what is cited in the literature, taught in the classroom, and practiced in the clinic. All respondents who taught direct pulp capping used calcium hydroxide as a base and a few would also consider glass ionomer as an alternative. This medicament selection concurred with the recommendations found in the literature.¹² Moreover, the respondents held true

Part I. DEFINITIONS OF PROCEDURES TAUGHT

Which of the pulp therapy procedures* for *primary teeth* are taught to the predoctoral dental students in your department?

- | | |
|---------------|---|
| 69.8% (37/53) | INDIRECT PULP TREATMENT:
Incomplete removal of carious dentin to avoid pulp exposure. A radio-opaque base is placed over the remaining affected dentin to stimulate healing and repair. The tooth is then restored with a material that seals the dentin from the oral environment. |
| 43.4% (23/53) | DIRECT PULP CAP: When a small pulp exposure occurs during cavity preparation or trauma, an appropriate biocompatible radiopaque base is placed in contact with the pulp prior to restoration. |
| 100% (53/53) | PULPOTOMY: Amputation of the infected or affected coronal pulp while retaining the "vitality" of some or all of the radicular pulp. The chamber is filled with a suitable base. |
| 94.3% (50/53) | PULPECTOMY: Gaining access to the root canals which are then debrided, enlarged, disinfected and filled with a resorbable material. |

* As defined by the American Academy of Pediatric Dentistry's "Guidelines for Pulp Therapy for Primary and Young Permanent Teeth".²

INDIRECT/DIRECT PULP TREATMENT

1. In your undergraduate program, what base is used in an indirect pulp treatment?
89.2% (33/37) Calcium hydroxide
21.6% (8/37) Zinc oxide-eugenol
16.2% (6/37) Glass ionomer
2. After completing an indirect pulp treatment procedure, a student would be instructed to:
56.8% (21/37) Restore the tooth and observe it, reentering only if symptoms arise
43.2% (16/37) Restore the tooth, then reenter it after a given time period regardless of the absence of pathology and symptoms
3. In your undergraduate program, what base is used in a direct pulp cap?
91.3% (21/23) Calcium hydroxide
8.7% (2/23) Glass ionomer or calcium hydroxide

PULPOTOMY

1. What medicament does your department advocate for a pulpotomy procedure?
71.7% (38/53) Formocresol (1:5 dilution)
22.6% (12/53) Formocresol (full strength)
3.8% (2/53) Ferric sulfate or formocresol (1:5 dilution)
1.9% (1/53) Cresatin
0.0% (0/53) Gluteraldehyde
0.0% (0/53) Calcium hydroxide
2. How long are students instructed to leave the medicated pellet in the pulp chamber before removing it for an initial evaluation?
94.3% (50/53) 5 min
5.7% (3/53) 2–4 min
0.0% (0/53) 1 min
0.0% (0/53) Longer than 5 min
3. In your undergraduate program, what base is used in a pulpotomy procedure?
92.4% (49/53) Zinc oxide-eugenol
5.7% (3/53) Zinc oxide-eugenol and formocresol
1.9% (1/53) Glass ionomer

PULPECTOMY

1. By what method do students mechanically debride the root canal(s)?
98.0% (49/50) Hand instruments (files, broaches, reamers etc.)
2.0% (1/50) Rotary instruments
0.0% (0/50) Sonic or ultrasonic instruments

2. Does your department recommend that the root canal(s) be enlarged?
48.0% (24/50) Yes
52.0% (26/50) No
3. What solution do students use to irrigate the root canal(s)?
34.0% (17/50) Sodium hypochlorite, full strength (5.25%)
24.0% (12/50) Sterile water/saline
20.0% (10/50) Sterile water/saline or local anesthetic solution
6.0% (3/50) Local anesthetic solution
6.0% (3/50) Tap water
4.0% (2/50) Sodium hypochlorite, 1:5 dilution
2.0% (1/50) Sodium hypochlorite, 1:2 dilution
2.0% (1/50) 50% sodium hypochlorite, 50% hydrogen peroxide
2.0% (1/50) Isopropyl alcohol
4. What material does your department advocate for the obturation (filling) of the root canal(s)?
90.0% (45/50) Zinc oxide-eugenol paste
4.0% (2/50) Zinc oxide-eugenol paste or iodoform paste
2.0% (1/50) Iodoform paste
2.0% (1/50) Zinc oxide-eugenol paste with formocresol added
2.0% (1/50) Calcium hydroxide
5. What technique does a student use to place the recommended filling material into the root canal?
26.0% (13/50) Syringe
22.0% (11/50) Hand condenser
14.0% (7/50) Syringe or hand condenser
14.0% (7/50) Lentulo spiral
12.0% (6/50) Lentulo spiral or hand condenser
10.0% (5/50) Lentulo spiral, hand condenser, or syringe
2.0% (1/50) Cotton pellet
6. How many appointments are advocated for completion of a pulpectomy procedure?
60.0% (30/50) One appointment (start to finish)
26.0% (13/50) Two appointments (extirpate, seal in a medicated pellet, observe then fill)
14.0% (7/50) Either one or two appointments
7. What frequency of exposure with periapical radiographs is recommended for follow-up evaluation of a pulpectomy procedure?
44.0% (22/50) Immediately after filling and then periodic evaluation
30.0% (15/50) Periodic evaluation only
16.0% (8/50) Only if adverse signs or symptoms develop
10.0% (5/50) Immediately after filling and then only if adverse signs or symptoms develop

when presented with a clinical scenario (case A-2) involving the possible selection of direct pulp capping as the treatment of choice. Almost half of programs (43%) taught the procedure and a slightly smaller number (34%) actually advocated its use in a selected hypothetical clinical scenario. As with the indirect pulp treatment, a majority (64%) of the respondents, when presented with a clinical situation meeting the criteria for direct pulp cap (case A-2), selected a more aggressive

modality (pulpotomy) instead. One might speculate that selection of a pulpotomy over an indirect or direct pulp cap was likely influenced by its reported higher success rate.⁵

Pulpotomy

The pulpotomy appeared to be the most universally taught and practiced pulp therapy procedure for primary teeth. The majority of programs replied that a 1:5

Part II. CLINICAL CASE SCENARIOS

A. For the following scenarios (1–6), the tooth in question is a *mandibular primary second molar* and the patient is 5 years old.

1. A student is performing deep caries removal. There is still caries present in the preparation, but if removed in its entirety, a minimal pulp exposure is imminent. What do you instruct the student to do next?
 - 73.6% (39/53) Continue to remove all caries and, if the pulp is exposed, initiate a pulpotomy procedure
 - 26.4% (14/53) Terminate caries removal and perform an indirect pulp treatment
2. You check a student's preparation and verify that he/she has removed all the caries. A few moments later, the patient bites down while the student is smoothing the walls of the prep with a high speed handpiece. Upon evaluation you note that there is a small bur hole in the pulpal floor of the prep. The pulp is exposed but not hemorrhagic. What do you instruct the student to do next?
 - 64.1% (34/53) Pulpotomy
 - 34.0% (18/53) Direct pulp cap
 - 1.9% (1/53) Partial pulpotomy (Cvek technique)
3. The student is excavating caries and a carious pulp exposure occurs. The radiograph reveals no pathologic root resorption nor obvious furcal or apical lucencies. There are no signs of a draining fistula or mobility. What do you instruct the student to do next?
 - 98.1% (52/53) Pulpotomy
 - 1.9% (1/53) Direct pulp cap
 - 0.0% (0/53) Pulpectomy
4. Three years following pulpotomy treatment, a periapical radiograph in this 8-year-old reveals pathologic root resorption but the primary second molar has no negative clinical signs or symptoms. What is your recommendation for continued care?
 - 58.5% (31/53) Observation only
 - 39.6% (21/53) Extraction and space maintenance
 - 1.9% (1/53) Pulpectomy
5. During a pulpotomy procedure, the amputated radicular pulp tissue is very hemorrhagic. Even after medicament application, hemostasis is difficult to achieve. Upon inspection of the tooth, you see that the pulp chamber is adequately unroofed and there is no evidence of coronal pulp tissue tags. The radicular pulp appears hyperemic to you. What do you instruct the student to do next?
 - 51.0% (27/53) Initiate a pulpectomy procedure
 - 26.4% (14/53) Seal a medicated pellet into the pulp chamber and reappoint for evaluation and further treatment (two-stage pulpotomy)

- 22.6% (12/53) Extirpate the coronal one-third of the radicular pulp (deep pulpotomy)
 - 0.0% (0/53) Extraction and space maintenance
6. A student's patient presents with a draining fistula associated with a large carious lesion, which is restorable. Radiograph reveals a small furcal lucency, but no pathologic root resorption, mobility, or percussion sensitivity. What do you instruct the student to do next?
 - 35.8% (19/53) Two-appointment pulpectomy (extirpate, observe, and fill, if favorable, on reappointment)
 - 32.1% (17/53) One-appointment pulpectomy
 - 28.3% (15/53) Extraction followed by space maintenance
 - 3.8% (2/53) Pulpotomy

B. For the following scenarios (1–3), the tooth in question is an *intact, discolored (gray) maxillary primary central incisor* and the patient is 3 years old. There are no other clinical signs or symptoms. Mother reports that the patient bumped the tooth in an accident 3 months ago.

1. The patient presents for recall. The radiograph shows no signs of pathology. What do you instruct the student to do next?
 - 90.6% (48/53) Observe until further signs or symptoms develop
 - 9.4% (5/53) Pulpectomy
 2. The patient presents for recall. The radiograph reveals a 2-mm, poorly defined apical lucency; all other findings as above. What do you instruct the student to do next?
 - 66.0% (35/53) Pulpectomy
 - 18.9% (10/53) Extraction
 - 15.1% (8/53) Observe until further symptoms develop
 3. The patient presents for recall. The radiograph reveals a 2-mm, poorly defined apical lucency, and a labial parulis associated with the tooth. All other findings as above. What do you instruct the student to do next?
 - 60.4% (32/53) Extraction
 - 39.6% (21/53) Pulpectomy
- C. For the following scenario, the tooth in question is a *maxillary primary central incisor* in a 3-year-old patient.
1. Patient presents with an Ellis class III fracture that occurred less than 1 hour ago. Soft tissues are intact, the tooth is in its natural position, and is only slightly mobile. Periapical radiograph is normal except for the fracture. What do you instruct the student to do next?
 - 56.6% (30/53) Pulpotomy
 - 22.5% (12/53) Pulpectomy
 - 7.6% (4/53) Direct pulp cap
 - 7.6% (4/53) Partial pulpotomy (Cvek technique)
 - 5.7% (3/53) Extraction

dilution of formocresol placed in the pulp chamber for 5 min and then filled with ZOE was their espoused pulpotomy technique. Two programs indicated ferric sulfate as an alternative selection to formocresol, and there has been recent support for this approach in the dental literature.¹³ It is interesting to note that no programs selected glutaraldehyde as a pulpotomy medicament of choice even though there has been much de-

bate in the literature regarding its efficacy.¹⁴ Most respondents (98%) chose the pulpotomy as the best treatment in the clinical scenario (case A-3) meeting the traditional selection criteria for a pulpotomy procedure.

The use of a 1:5 dilution of formocresol was reported to be clinically successful as a pulpotomy medicament in primary teeth.¹⁵ Ranly and Garcia-Godoy⁸ pointed out that while the 1:5 dilution was routinely accepted,

this dilution level was arrived at arbitrarily. They also suspected that this dilution was not used as often as it was advocated because it had to be individually prepared, as no diluted solution was commercially available. On the issue of the length of time the formocresol pellet was left in the chamber, Mathewson and Primosch⁵ suggested 2-min placement before assessing hemorrhage control, and reapplication for another 2 min if hemostasis was not initially achieved. Ranly⁹ commented that the 5-min application was a step back from the early multiple appointment procedure. It caused incomplete mummification and sterilization of the pulp tissue, and the only rationale for its use was its empirical success. In light of these arguments, Ranly raised the question: Is the 5-min formocresol pulpotomy used because it is a biologically sound treatment or simply because it has a high degree of success? It is of interest to note that when presented with a clinical scenario (case A-4) of a failing pulpotomy procedure, educators were split as to whether further treatment was indicated.

Pulpectomy

The pulpectomy procedure was one of the approaches to pulp therapy with the least amount of consensus among educators, even though it was taught by 94% of the programs. Although nearly universally taught, there was great disparity among programs as to the appropriate selection criteria for this procedure as evident from the responses to cases A-5 and -6, B-1 through -3, and C-1. The respondents and the literature agreed that hand instrumentation (files, reamers, broaches) was the preferred way to debride the canals. However, the respondents were equally split on whether the canals should be enlarged. Literature can be cited to support both sides of this argument. Likewise, there was no consensus of the respondents or literature surveyed, which supported a unified approach to the selection of irrigating solutions, technique for obturating the canals, number of appointments for completion, and frequency of follow-up radiographs. Most respondents (94%) and literary sources cited ZOE as the best obturating material. However, a few programs selected the use of iodoform paste, as recently advocated in the literature.^{4, 8, 11} Holan and Fuks presented evidence that iodoform paste met more of the criteria for an ideal canal filling material than did ZOE.¹¹ Reasons given for the use of iodoform paste included better biocompatibility, resorbability, and disinfectant properties. The results of this survey indicated that the use of iodoform paste was not widely taught in this country.

This survey demonstrated a lack of consensus among predoctoral pediatric dental educators as to the preferred treatment modalities and techniques for primary tooth pulp therapy. It is possible to speculate that due to the relatively high success rates of conventional treatments, there was little impetus for research into improving and/or changing the existing traditional approaches. The wide range of clinical acceptability of

the results of various pulp treatments may outweigh the need to select more effective therapies based on sound scientific research.

Conclusions

The survey results can be summarized as follows:

1. The vast majority of dental schools teach indirect pulp treatment, pulpotomy, and pulpectomy. Programs that teach direct pulp capping are in the minority.
2. Calcium hydroxide is the base chosen most for both direct and indirect pulp treatment.
3. A 1:5 dilution of formocresol applied for 5-min is the preferred technique in a pulpotomy procedure.
4. Zinc oxide-eugenol is the most frequently selected filling material in both pulpotomy and pulpectomy procedures.
5. Many differences of opinion still exist in the areas of pulpectomy techniques and procedure selection criteria.
6. Disagreements concerning the best treatment option were common among dental educators responsible for teaching primary tooth pulp therapy to predoctoral pediatric dental students.

Dr. Primosch is a professor and director, Dr. Glomb is a resident, and Dr. Jerrell is an associate professor, all in the Department of Pediatric Dentistry, College of Dentistry, University of Florida, Gainesville.

1. Spedding R: Pulp therapy for primary teeth—survey of the North American dental schools. *J Dent Child* 35:360-67, 1968.
2. American Academy of Pediatric Dentistry: Reference Manual. Guidelines for pulp therapy for primary and young permanent teeth. *Pediatr Dent* 16 (7):53-54, 1994.
3. Kopel HM: Considerations for the direct pulp capping procedure in primary teeth: a review of the literature. *ASDC J Dent Child* 59:141-49, 1992.
4. Fuks AB: Pulp therapy for the primary dentition. In: *Pediatric Dentistry: Infancy through Adolescence*, 2nd ed. Pinkham JP et al, Ed. Philadelphia: WB Saunders Co, 1994, pp 326-38.
5. Mathewson RJ, Primosch RE: Pulp treatment. In: *Fundamentals of pediatric dentistry*, 3rd ed. Mathewson RI, Primosch RE. Chicago: Quintessence, 1995.
6. McDonald RE Avery DR: Treatment of deep caries, vital pulp exposure, and pulpless teeth. In: *Dentistry for the Child and Adolescent*, 6th ed. St Louis: CV Mosby Co, 1994.
7. Avram DC, Pulver F: Pulpotomy medicaments for vital primary teeth. Surveys to determine use and attitudes in pediatric dental practice and in dental schools throughout the world. *ASDC J Dent Child* 56:426-34, 1989.
8. Ranly DM, Garcia-Godoy F: Reviewing pulp treatment for primary teeth. *J Am Dent Assoc* 122:83-85, 1991.
9. Ranly DM: Pulpotomy therapy in primary teeth: new modalities for old rationales. *Pediatr Dent* 16:403-9, 1994.
10. Camp J: Pulp therapy for primary and young permanent teeth. *Dent Clin North Am* 28:651-68, 1984.
11. Holan G, Fuks A: A comparison of pulpectomies using ZOE and KRI paste in primary molars: a retrospective study. *Pediatr Dent* 15:403-7, 1993.
12. Jerrell RG, Courts FJ, Stanley HR: A comparison of two calcium hydroxide agents in direct pulp capping of primary teeth. *J Dent Child* 51:34-38, 1984.
13. Fei A, Udin RD, Johnson R: A clinical study of ferric sulfate as a pulpotomy agent in primary teeth. *Pediatr Dent* 13:327-32, 1991.
14. Garcia-Godoy F: Clinical evaluation of glutaraldehyde pulpotomies in primary teeth. *Acta Odontol Pediatr* 4:41-44, 1983.
15. Fuks AB, Bimstein E: Clinical evaluation of diluted formocresol pulpotomies in primary teeth of school children. *Pediatr Dent* 3:321-24, 1981.