Scientific Article

Pediatric and General Dentists' Attitudes toward Pulp Therapy for Primary Teeth

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Abstract: ***Purpose:*** *The purpose of this survey was to assess and compare the attitudes of pediatric and general dentists regarding treatment planning of indirect pulp therapy (IPT) in primary teeth.* ***Methods:*** *A 15-item electronic survey was sent to 3,883 general dentists and 3,691 pediatric dentists nationwide to assess their knowledge and attitudes regarding the treatment planning of IPT through the presentation of clinical scenarios.* ***Results:*** *Of the 7,574 electronic surveys distributed, 1,259 (17%) were completed. When presented with a clinical scenario where IPT would be an appropriate choice, 41% of general dentists and 28% of pediatric dentists selected IPT as treatment of choice (P<.01).* ***Conclusion:*** *Most general and pediatric dentists do not regularly treatment plan indirect pulp therapy for primary teeth. Pediatric dentists are less likely than general dentists to do so. Most surveyed believe pulpotomy is a more successful vital pulp therapy than IPT. There are significant differences between pediatric and general dentists in terms of treatment planning and materials utilized in vital pulp therapy.* *(Pediatr Dent 2012;34:210-5) Received July 16, 2010 / Last Revision October 22, 2010 / Accepted November 11, 2010*

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The Guideline on Pulp Therapy for Primary and Immature Permanent Teeth from the American Academy of Pediatric Dentistry (**AAPD**) recognizes 2 treatment options for vital primary teeth with deep caries approaching the pulp. These treatment options are indirect pulp therapy (**IPT**) and pulpotomy.[1] IPT is a procedure where the carious dentin near the pulp is left intact to avoid a pulp exposure and is covered by a biocompatible material to prevent leakage.[1-7] Unlike IPT, a pulpotomy is performed when complete removal of carious dentin results in a pulp exposure. The coronal pulp is then amputated and the remaining pulp is treated with formocresol, ferric sulfate, mineral trioxide aggregate (**MTA**), or electrosurgery.[1,7-16] Both IPT and pulpotomy are indicated in teeth diagnosed with reversible pulpitis.[1]

For years, pulpotomy has been the standard treatment for a deep carious lesion where complete caries removal results in a vital pulp exposure. Primosch reported that 74% of predoctoral instructors preferred pulpotomy over 26% who preferred IPT in a primary molar where complete caries removal would result in a pulp exposure.[17] Dunston and Coll repeated the same survey in 2005 and, in addition to dental school program directors, also surveyed board-certified pediatric dentists.[18] The same question concerning deep caries removal in a primary molar was presented. Seventy percent of program directors and over 80% of pediatric dentists chose pulpotomy as the treatment of choice over IPT.[18]

Historically, formocresol has been the medicament of choice for the primary tooth pulpotomy. The use of formocresol as a pulpal medicament became popular in the early 1900s when Buckley first published his method of using equal parts of tricresol and formalin.[19] Although the procedures and formulation have changed since this first publication, formocresol has remained popular as a medicament for vital pulp therapy. The 2005 survey by Dunston and Coll reported that 81% of surveyed pediatric dentist diplomates used diluted or full-strength formocresol, 18% used ferric sulfate, and 1% used some other medicament or technique for primary tooth pulpotomies.[18]

Over the last few decades, concerns about the toxic effects of formocresol have led to the re-examination of its use in dentistry. While it is known that the amount of formaldehyde exposure during a single pulpotomy is quite low compared to the daily intake of formaldehyde from the environment, concerns about its use in dentistry have persisted.[20,21] This is most likely due to the fact that higher levels of formaldehyde have been shown to have carcinogenic, cytotoxic, and genotoxic effects.[22]

Partly driven by these concerns, IPT has increased in popularity over the last decade.[18] In addition to the desire to eliminate formocresol, success rates of IPT have been reported that are equal to or greater than that of the pulpotomy. With the exception of the MTA pulpotomy, a range of pulpotomy success rates have been reported from greater than 90% to less than 70%.[2] These success rates have been shown to decrease over time, regardless of the material used. The formocresol pulpotomy has been reported to have an initial (6-12 months) success rate of 92%. When studies have followed the formocresol pulpotomy over longer periods of time (36-40 months) these success rates drop to 70%.[23] IPT studies have consistently shown success rates of over 90%, regardless of the material used (calcium hydroxide or glass ionomer) or the amount of time followed.[2] Farooq et al., reported a 93% success rate for IPT when followed for 50 months.[23]

Concerns over the safety of formocresol, combined with an increased interest in IPT due to the high success rates reported,

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have led many to question whether dentists should continue to routinely elect to perform a formocresol pulpotomy instead of IPT. In a review of the literature, Coll reports that IPT "has been shown to have a lower cost, higher success rate, better exfoliation pattern, and better success treating reversible pulpitis than pulpotomy."[2] This view, however, has not been routinely incorporated into practice, with over 80% of surveyed board certified pediatric dentists reporting they prefer pulpotomy over IPT.[18]

The purpose of this investigation was to determine pediatric vs general dentists' opinions regarding pulp therapy in primary teeth.

Methods

Pediatric and general dentists' attitudes regarding IPT were examined by use of an online electronic survey. Only practicing pediatric and general dentists were included in the survey. The pediatric dentists surveyed were all members of the AAPD, and their e-mail addresses were provided by the Academy. Recruited to participate in this study were 3,691 pediatric dentists. The general dentists surveyed were selected randomly from a list purchased from dentistlistpro.com, a company specializing in medical and dental provider information for marketing purposes. A total of 3,883 general dentists were asked to participate in the survey.

The questionnaire was developed using SurveyMonkey (SurveyMonkey, Palo Alto, Calif), an online survey tool. Subjects were invited to participate in the study by e-mail, which included a description of the research and a hyperlink to the online survey. One follow-up e-mail was sent 2 weeks after the initial request to encourage participation of those who had not yet completed the questionnaire. The research project and questionnaire were approved by the Institutional Review Board of the University of Kentucky, Lexington, Ky.

The survey focused on the presentation of clinical cases through the use of written descriptions and radiographs to ascertain the respondent's attitudes regarding the treatment planning of IPT in various cases. Cases 1 and 2 were presented as scenarios where IPT would be an appropriate treatment option. To ensure that these teeth were, in fact, candidates for IPT, radiographs were selected of cases that had successfully been treated with IPT and which had long-term follow-up data. The accompanying clinical descriptions were altered to present different study variables. Case 3 was presented as a scenario in which either a pulpectomy or extraction would be an appropriate treatment option. A radiograph was selected of a patient whose primary tooth was extracted due to presenting with signs and symptoms of irreversible pulpitis.

Continuous variables were summarized with descriptive statistics (sample size, means, standard deviations), and categorical outcomes were described with counts and percentages. Participants were divided into 2 groups: (1) pediatric dentists; and (2) general dentists. Comparisons were made using 2-group *t* tests and chi-square tests of independence for continuous and categorical data, respectively. A logistic regression was also performed. *P*-values less than .05 were considered statistically significant for all statistical tests. All analyses were performed using SAS 9.2 (SAS Institute, Inc, Cary, NC).

Results

Of the 7,574 dentists invited to participate in the study, 1,259 (17%) completed the online survey. Three hundred six (8%) of 3,883 general dentists and 953 (26%) of 3,691 pediatric dentists responded.

The general dentists who completed the survey were asked how frequently they treat children in their practice to determine their interest and experience in pediatric dentistry. Forty-six percent (141/306) reported frequently (1-2 times per day) or very frequently (more than 2 times a day) treating children in their practices.

When asked about their clinical experience, 62% (186/298) of general dentists reported being in practice for more than 21 years. Among pediatric dentists, 66% (622/944) reported being in practice for less than 20 years.

When asked if they were trained to perform IPT in dental school or residency, 69% (198/289) of general dentists and 60% (564/943) of pediatric dentists responded positively. Participants were then asked how often they treatment plan IPT in their practice. Three percent (9/290) of general dentists and 37% (348/944) of pediatric dentists indicated they frequently (1-2 times per week) or very frequently (more than 1-2 times

Table 1. RESPONSES FOR CASE NOS. 1, 2, AND 3*

	Total participants N (%)	General dentists N (%)	Pediatric dentists N (%)	*P*-value
Case 1 (N)	1,217	285	932	<.01
Pulpotomy	738 (61)	128 (45)	610 (65)	
Indirect pulp therapy	376 (31)	116 (41)	260 (28)	
Pulpectomy	25 (2)	10 (3)	15 (2)	
Other	78 (6)	31 (11)	47 (5)	
Case 2 (N)	1,203	280	923	<.01
Pulpotomy	931 (77)	182 (65)	749 (81)	
Indirect pulp therapy	116 (10)	38 (14)	78 (8)	
Pulpectomy	90 (8)	37 (13)	53 (6)	
Other	66 (5)	23 (8)	43 (5)	
Case 3 (N)	1,197	280	917	<.01
Pulpotomy	517 (43)	148 (53)	369 (40)	
Indirect pulp therapy	13 (1)	7 (3)	6 (1)	
Pulpectomy	439 (37)	79 (28)	360 (39)	
Other	228 (19)	46 (16)	182 (20)	

* The sample size for each case represents the number of participants who provided responses.

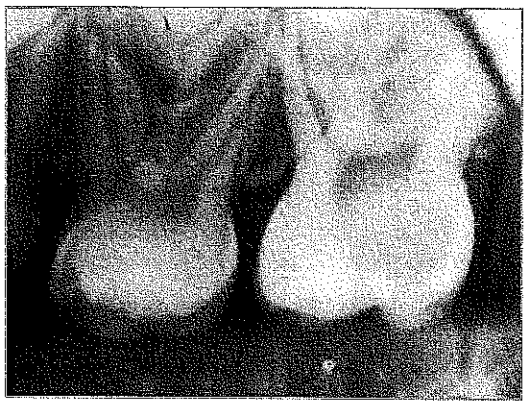

Figure 1. Radiograph presented with Case 1.

per week) performed IPT in their office. Twenty-six percent (76/290) of general dentists and 16% (148/944) of pediatric dentists report that they never perform IPT on primary teeth.

Participants were presented with a hypothetical scenario of a deep carious lesion in a primary molar. Subjects were told that complete caries removal would potentially result in a pulp exposure and to assume that the tooth was vital, presented with no pain, and had no noticeable periradicular pathology. Sixty-three percent (593/934) of the pediatric dentists surveyed indicated they would perform a pulpotomy, while only 32% (297/932) said they would initiate IPT. General dentists were more likely than pediatric dentists to attempt IPT in this scenario, with 43% (122/285) selecting pulpotomy and 42% (121/285) selecting IPT ($P<.01$).

Survey participants were presented with a series of clinical scenarios and asked questions about how they would treatment plan each case. Follow-up questions were asked based on the choice selected. Each case contained a radiograph of a decayed primary molar and a written clinical description. The choice of pulp therapy for cases 1, 2, and 3 are presented in Table 1.

Case 1. A radiograph (Figure 1) and the following clinical scenario were presented:

A 4-year-old child presents to your practice with deep decay on a primary maxillary second molar. The mother and patient report no history of pain. You assume that complete caries removal would potentially result in a vital pulp exposure. A periapical radiograph was taken and appears below.

The choice of pulp therapy for Case 1 is presented in Table 1. The majority (65%) of pediatric dentists indicated they would treatment plan pulpotomy in this situation with 28% reporting they would attempt IPT. General dentists were more likely to treatment plan IPT than pediatric dentists, with 41% indicating that IPT would be their treatment of choice ($P<.01$). Still, as with pediatric dentists, the largest number of general dentists (45%) selected pulpotomy as their preferred treatment for this case.

A logistic regression was performed to control for confounding variables. Variables controlled for were: (1) number of years in practice; (2) frequency in which participants perform IPT in their practice; and (3) whether they were trained to perform IPT in dental school or residency. When these variables were controlled, general dentists showed a 3.6 times increase in odds to treatment plan IPT than pediatric dentists.

As an additional analysis, general dentists were recategorized according to the frequency of treating children: treat children rarely and treat children often. These 2 groups of general dentists tended to provide similar responses to the questionnaire. In fact, there were no significant differences between these 2 groups on the primary questions of interest. While general dentists who treat children often did have responses that were more similar to pediatric dentists than general dentists who rarely treat children, there were still significant differences between the general dentists who treat children often and pediatric dentists on the primary outcomes. Therefore, the general dentists were combined for the main analysis and for comparisons to pediatric dentists.

The reasons for selecting pulpotomy as the treatment of choice are presented in Table 2. When asked why they chose pulpotomy over IPT, 62% of pediatric dentists and 55% of general dentists said they felt pulpotomy is more successful than IPT. To the same question, 34% of pediatric dentists and 24% of general dentists stated that there are not enough data to support the use of IPT in

Table 2 REASONS FOR PLANNING PULPOTOMY INSTEAD OF INDIRECT PULP THERAPY IN CASE 1

	Total participants (N=738) N (%)	General dentists (N=128) N (%)	Pediatric dentists (N=610) N (%)	*P*-value
Pulpotomy is more successful than indirect pulp therapy				.18
No	290 (39)	57 (45)	233 (38)	
Yes	448 (61)	71 (55)	377 (62)	
Reimbursement rate is higher for pulpotomy				.73
No	702 (95)	121 (95)	581 (95)	
Yes	36 (5)	7 (5)	29 (5)	
There is not enough data to support the use of indirect pulp therapy in primary teeth				.03
No	498 (67)	97 (76)	401 (66)	
Yes	240 (33)	31 (24)	209 (34)	
What material would you use to complete the pulpotomy? (N)	730	125	605	<.01
Formocresol (full strength)	214 (29)	66 (53)	148 (24)	
Formocresol (diluted)	286 (39)	20 (16)	266 (44)	
Ferric sulfate	156 (21)	19 (15)	137 (23)	
Mineral trioxide aggregate	10 (1)	4 (3)	6 (1)	
Electrosurgery	9 (1)	0 (0)	9 (2)	
Other	55 (8)	16 (13)	39 (6)	

* No. of responses for the last question is different due to missing data.

Figure 2. Radiograph presented with Case 2.

Figure 3. Radiograph presented with Case 3.

primary teeth. When asked if reimbursement rates for the 2 procedures impacted their decision, 5% of pediatric dentists and 5% of general dentists identified that it was a factor in their treatment planning process. Most general and pediatric dentists do not differ in their motivations for choosing pulpotomy over IPT.

Of those dentists who selected pulpotomy as their treatment of choice, additional follow-up questions were asked to determine what material they would use to complete the pulpotomy. These results are presented in Table 2. Of the pediatric dentists questioned, 68% selected formocresol, 23% ferric sulfate, and 1% MTA. Responses from general dentists were similar, with 69% selecting formocresol, 15% ferric sulfate, and 3% MTA. Of those who indicated they would use formocresol, general dentists were more likely to use full strength instead of diluted formocresol than pediatric dentists ($P<.01$).

Of those who chose to treatment plan IPT for the above case, additional questions were asked to ascertain what techniques were most widely used and are reported in Table 3. The vast majority (89% of pediatric dentists and 74% of general dentists) indicated they would complete the IPT using a 1-step technique vs 8% of pediatric dentists and 22% of general dentists who would employ stepwise caries removal. The most popular choice for medicament material after caries removal for pediatric dentists was glass ionomer (61%) followed by calcium hydroxide (25%). The most commonly used medicament material after caries removal for general dentists was calcium hydroxide (40%) followed by glass ionomer (34%). Forty-seven percent of pediatric dentists would restore with full-coverage stainless steel vs only 4% of general dentists ($P<.01$). The most popular choice for restorative material for general dentists was composite resin, with 63% reporting this would be their material of choice.

Case 2. A radiograph (Figure 2) and the following clinical scenario were presented:

A 5-year-old child presents to your office with deep decay in a primary mandibular second molar. The mother and patient report a history of transient (elicited) pain upon eating or drinking. You assume that complete caries removal would potentially result in a pulp exposure. A periapical radiograph is taken and appears below.

The choice of pulp therapy for Case 2 is presented in Table 1. When a history of elicited pain was reported, an increase in the percentage of both pediatric and general dentists who would treatment plan pulpotomy over IPT was observed. Eighty-one percent of pediatric dentists and 65% of general dentists stated they would perform a pulpotomy in this situation. Only 8% of pediatric dentists and 14% of general dentists would initiate IPT for this tooth. As in the previous case, general dentists are more likely to attempt IPT than pediatric dentists in this case of elicited pain ($P<.01$).

Case 3. A radiograph (Figure 3) and the following clinical scenario were presented:

A 5-year-old child presents to your office with deep decay in a primary maxillary second molar. The mother and patient report a history of spontaneous pain at night. You assume that complete caries removal would potentially result in a pulp exposure. A periapical radiograph is taken and appears below.

The choice of pulp therapy for Case 3 is presented in Table 1. The history presented with this case indicates that this tooth is irreversibly inflamed.[1] Forty percent of pediatric dentists and 53% of general dentists, however, indicated that pulpotomy would be their planned treatment. Only 1% of pediatric dentists and 3% of general dentists revealed they would attempt IPT in this situation. Significantly more pediatric dentists (39 %) than general dentists (28%) chose pulpectomy as their treatment of choice ($P<.01$). Twenty percent of pediatric dentists and 16% of general dentists questioned answered "other" in this case. Of those who selected "other" as a treatment option, both general dentists and pediatric dentists indicated they would extract the tooth.

Discussion

The use of IPT in primary teeth has become increasingly popular over the past decade. While the success rates for IPT presented in the literature are higher than that of pulpotomy,[2]

Table 3. FOLLOW-UP QUESTIONS FOR CASE 1 AMONG THOSE WHO CHOSE INDIRECT PULP THERAPY

	Total participants N (%)	General dentists N (%)	Pediatric dentists N (%)	*P*-value
What technique would you use to complete indirect pulp therapy in Case 1? (N)	372	116	256	<.01
1-step caries removal: Caries removal followed by immediate placement of a final restoration	314 (84)	86 (74)	228 (89)	
Stepwise caries removal: Caries removal followed by a temporary restoration; next, plan to re-enter the tooth to evaluate prior to placing a final restoration	45 (12)	25 (22)	20 (8)	
Other	13 (4)	5 (4)	8 (3)	
What material would you use as a medicament for indirect pulp therapy in the Case 1? (N)	372	116	256	<.01
Calcium hydroxide	111 (30)	46 (40)	65 (25)	
Zinc oxide eugenol	17 (4)	7 (6)	10 (4)	
Glass ionomer	197 (53)	40 (34)	157 (61)	
Resin composite	14 (4)	11 (10)	3 (1)	
Other	33 (9)	12 (10)	21 (8)	
How would you restore the tooth in Case 1 after completing indirect pulp therapy? (N)	374	116	258	<.01
Amalgam restoration	34 (9)	22 (19)	12 (5)	
Composite resin restoration	172 (46)	73 (63)	99 (38)	
Stainless steel crown	125 (33)	5 (4)	120 (47)	
Other	43 (12)	16 (14)	27 (10)	

* No. of responses for individual questions may vary due to missing data.

there continues to be a significant number of practitioners who are resistant to incorporate this treatment into their daily practice. In addition to being more successful than pulpotomy, IPT is potentially easier and less expensive to perform. This suggests that the failure to incorporate this treatment into the regular practice of pediatric and general dentists is due largely to lack of knowledge and misconceptions present in the dental community.

One possible reason for not incorporating IPT into practice could be attributed to a lack of training in pre- and postdoctoral programs. The fact that pediatric dentistry postdoctoral program directors favor pulpotomy over IPT likely has an effect on pediatric dentists' considering IPT as a viable treatment option for the primary dentition.[17,18] A more evidence-based approach to the teaching of vital pulp therapy may increase the use of IPT in dental practice.[26]

It has also been suggested that differences in reimbursement rates for pulpotomy and IPT could affect the dentist's treatment planning process.[18] The vast majority (95%) of those questioned in this survey indicated this was not a factor in their decision-making process. This indicates that reasons for selecting pulpotomy over IPT are clinical in nature and not influenced by financial motives. Even though those questioned in this study did not identify it as a factor in their treatment planning, previous studies have shown that reimbursement rates do have some impact on dentist's practice behaviors.[24,25]

Dentists completing this questionnaire indicated 2 major factors leading to their preference of pulpotomy over IPT. Many pediatric and general dentists believed that pulpotomy is more successful than IPT or that there are not enough data to support the use of IPT in primary teeth. Both of these responses appear to reflect a lack of familiarity and understanding of the current dental literature on pulp therapy.[26] When presented with a clinical scenario that included a history of pain, pediatric and general dentists were much less likely to treatment plan IPT, even if the history of pain is consistent with a reversibly inflamed pulp. This suggests that dentists believe pulpotomy is a more definitive and successful treatment for reversible pulpitis and are unwilling to attempt the more conservative IPT.

One factor that was not directly addressed in this questionnaire, but which could explain why dentists would prefer pulpotomy over IPT, is the difficulty in accurately diagnosing pulpal status. IPT is only indicated in a tooth with a healthy or reversibly inflamed pulp. Since there is no reliable method to determine pulpal status (other than a clinical determination based on the reported history of symptoms) many dentists are reluctant to initiate IPT.

There are clear differences in the attitudes of pediatric and general dentists regarding IPT treatment planning. This study illustrates that general dentists are more willing to attempt IPT on primary teeth than pediatric dentists. In every case scenario presented where IPT was an appropriate choice, general dentists were more likely to select it as their preferred treatment. Pediatric dentists as a group indicate they are most comfortable with the more traditionally accepted pulpotomy as their choice for vital pulp therapy. This may be explained by the historic importance of the pulpotomy in pediatric dentistry and pediatric dentists' resistance to incorporating new treatment options into their practice. It may also be explained by the fact pediatric dentists have more training in performing pulpotomies. Seale and Casamassimo found a correlation between the types of educational experiences provided in dental school and general dentists' willingness to provide these treatments in their practice.[29] Since general dentists presumably have less clinical training in providing primary tooth pulpotomies and their subsequent restoration, their increased willingness to attempt IPT may be an attempt to avoid performing a pulpotomy.

There are significant differences in the materials utilized by pediatric and general dentists for both pulpotomy and IPT. Both groups indicated formocresol is still the most popular choice for a pulpotomy medicament, despite published concerns regarding its potential toxicity. General dentists as a group preferred full-strength formocresol while the majority of pediatric dentists prefer diluted formocresol. Full-strength and diluted formocresol have been shown to have similar success rates, thus suggesting the difference is clinically insignificant.[27] The choice of a medicament for IPT also differed significantly between pediatric and general dentists. While both preferred a 1-step technique, most pediatric dentists indicated they would place glass ionomer after caries removal while general dentists as a group preferred placing calcium hydroxide. Both materials have been evaluated and have similar success rates, again suggesting a clinically insignificant difference in preference.[2,28] Lastly, there were differences reported in the type of restoration placed after IPT. General dentists were much less likely to restore with a stainless steel crown than pediatric dentists.

In lieu of full coverage, most general dentists indicated composite resin would be their restoration of choice. IPT has been shown to be significantly more successful when combined with full-coverage stainless steel than when combined with an intracoronal restoration.[4] General dentists' reluctance to utilize a full-coverage restoration can most likely be attributed to lack of education and clinical experience with stainless steel crowns.[29]

A significant percentage of both pediatric and general dentists surveyed demonstrated a lack of understanding of nonvital pulp therapy illustrated by responses given to Case 3. A large percentage of participants indicated they would attempt a pulpotomy on a tooth that was irreversibly inflamed based on the accompanying history of spontaneous nocturnal pain. This reinforces the importance of a clinician's diagnostic skills in selecting the appropriate form of pulp treatment.

This study's major limitations include the low overall response rate to the questionnaire and the significant difference in sample sizes of the 2 study groups. The sample size discrepancy can be attributed to the way in which participants of the 2 groups were recruited. Pediatric dentists were identified and contacted through information provided by the AAPD. General dentists were selected from a list purchased from a company specializing in medical and dental provider information for marketing purposes. Requests to participate were sent to approximately equal numbers of dentists from each group. Contact information obtained for general dentists proved to be less reliable, yielding fewer results and creating a discrepancy in sample sizes. This sample size difference could potentially bias the results and allowed for less precise estimates for the smaller general dentist study group.

The results reported in the study suggest there is no current consensus as to which form of vital pulp therapy is most appropriate for primary teeth. Though the use of IPT has increased over the past decades, the study results suggest that it is still less utilized than pulpotomy. For IPT to become the standard of care for vital primary teeth with deep caries, dentists need better education in the diagnosis of pulpal status, indications for IPT, and its reported success compared to pulpotomy.

Conclusions

Based on this study's results, the following conclusions can be made:

1. In a case of deep decay in a primary molar where indirect pulp therapy is an appropriate treatment option, the majority of respondents would treatment plan a pulpotomy and significantly more general dentists would perform IPT than pediatric dentists.
2. Most surveyed believe that pulpotomy is more successful than IPT.
3. There are significant differences between pediatric and general dentists in terms of treatment planning and materials utilized in vital pulp therapy.
4. There is no consensus among dentists as to which vital pulp therapy is most appropriate for primary teeth.

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