Pulpotomy in Primary Dentition: Current Practice and Knowledge of Emerging Materials among Nigerian Paediatric Dentists

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ABSTRACT

Objective: To assess the current pulpotomy practices and knowledge of emerging pulpotomy materials among Nigerian paediatric dentists

Methods: This study was a cross-sectional survey using a self-administered questionnaire via google form. A structured online questionnaire via google form was sent via WhatsApp monthly from July 2024 till October 2024 in which participants were asked to fill the google form after giving an online informed consent. The questionnaire used was a modification of that used in a similar study. It included questions on use of the vital pulpotomy technique for primary molars; use of preoperative and follow-up assessment radiographs; use of local anaesthesia; choice of pulpotomy agent; choice of restorative material for definitive restoration of molars treated by vital pulpotomy; and management of failures. Other questions were on concerns about preferred pulpotomy agents, willingness to use safer agents and knowledge of natural pulpotomy medicaments.

Results: Forty-nine paediatric dentists participated in the study, consisting of 13 males (26.5%) and 36 females (73.5%). The population was made up of specialists (40.8%), senior registrars (26.5%) and registrars (32.7%). 98% of participants practice vital pulpotomy in primary dentition. The most favoured pulpotomy medicament was formocresol, used by thirty-five (71.4%) respondents. Seventeen (34.7%) participants used glass ionomer cement and stainless-steel crowns as final restorative material following pulpotomy. A pulpectomy procedure was preferred by thirty-five (71.4%) respondents in cases of failure of pulpotomy treatment. More than half of the participants 33 (67.3%) expressed concerns about the use of their preferred pulpotomy medicament, with 22(62.9%) respondents who use formocresol expressing concerns on safety and toxicity. Majority (77.6%) of study participants expressed willingness to use a safer pulpotomy agent if available. Twenty-nine (59.1%) respondents were unaware of natural pulpotomy medicaments as newer agents for pulpotomy. Among the participants who demonstrated awareness of natural agents, aloe vera was the most common agent mentioned by 18(45%) respondents. Thirty-four (67.3%) of participants expressed willingness to use a natural pulpotomy medicament if available.

Conclusion: This study highlights that pulpotomy remains a widely practiced and essential procedure in management of primary molars among Nigerian Paediatric Dentists, with varying practices and knowledge of emerging materials. Standardization of pulpotomy protocols and continuing education on newer materials are essential to optimize treatment outcomes.

Keywords: Pulpotomy, Primary dentition, Paediatric dentists, Nigeria

INTRODUCTION

Preservation of the pulp in the primary dentition is an important aspect of paediatric dentistry as it plays a crucial role in the maintenance of the integrity of the dental arches as well as aesthetics, prevention of space loss and malocclusion (Hassan *et al.*, 2021).

Pulpotomy is considered the most common treatment option utilized in the treatment of primary molars with pulpal exposure (Gisoure, 2011; Bossù *et al.*, 2020). It is defined as "the surgical removal of the coronal part of an exposed vital pulp as a means of maintaining the function and vitality of the remaining radicular pulp" (American Academy of Pediatric Dentistry, 2020). The coronal pulp is removed surgically, pulpal haemorrhage is controlled, and the remaining vital radicular pulp is treated with a medicament with long term clinical success. It aims to preserve the vitality of the radicular pulp whilst keeping the tooth in the arch for as long as possible until natural exfoliation and preventing the issues associated with early loss of primary teeth (Park *et al.*, 2019). It is based on the rationale that beyond the area of infected dentin in the coronal pulp there is a layer of vital pulp with immunogenic potential for self-healing if infecting agents are isolated (Fuks, 2002). Pulpotomy is indicated in primary molars when there are features of reversible pulpitis, traumatic pulp exposure or from removal of deep caries, where the tooth has no radiographic sign of root resorption or pathology (Camp, 2008).

Various medicaments have been used for pulpotomy in primary teeth. The ideal medicament should be biocompatible, bactericidal, promote healing of the remaining radicular pulp and should not interfere with natural exfoliation process (Saikiran *et al.*, 2018; Adithya Nair *et al.*, 2023). Over the years formocresol has been considered as the gold standard medicament due to its long-term use and excellent clinical success (American Academy of Pediatric Dentistry, 2020) with a success rate of 70-98% according to various studies (Holan *et al.*, 2005; Bahrololoomi *et al.*, 2008; Ruby *et al.*, 2013; Parisay *et al.*, 2015) as well as ease of use. In recent times, there has been growing concerns with the continued use of formocresol with reports of systemic absorption, mutagenicity, cytotoxicity, immunogenicity and carcinogenicity (Hamaguchi and Tsutsui, 2000; Collins and Lineker, 2004; International Agency for Research on cancer, 2004; Lewis, 2009; Dungarwal *et al.*, 2018)

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Alternatives for formocresol have been proposed including mineral trioxide aggregate (MTA), ferric sulphate, sodium hypochlorite, laser, among others, with MTA recommended for use if primary molars are to be retained for over 24 months while others have conditional recommendations (Dhar *et al.*, 2017), with MTA and ferric sulphate being the most favoured for primary molar pulpotomies (Park *et al.*, 2019). Globally, there has been a gradual shift towards use of emerging materials because of their superior biocompatibility and clinical outcomes (Purohit *et al.*, 2017; Gomaa and Allam, 2020). Among these emerging materials are natural agents which have been enlisted in the continued search for ideal pulpotomy agents with materials such as honey, aloe vera, turmeric, propolis, *Alium sativum* (garlic) oil (Saikiran *et al.*, 2018; Park *et al.*, 2019) being considered.

Although the American Academy of Pediatric Dentistry in its reference manual (American Academy of Pediatric Dentistry, 2016) gives a clear guideline for pulpotomy in primary teeth including, indications, objectives, medicaments and practice among paediatric dentists worldwide, in Nigeria, paediatric dentistry is practiced in diverse settings across the different geopolitical zones with varying access to materials and continuing education. While there are studies assessing pulpotomy techniques and material preference in other climes (Hunter and Hunter, 2003; Hingston *et al.*, 2007), there is limited data on current pulpotomy practices and knowledge of emerging pulpotomy materials among Nigerian Paediatric Dentists. Understanding these factors is essential for improving clinical outcomes guiding curriculum development and informing policy and procurement decisions. Hence this study objective was to assess the current pulpotomy practices and knowledge of emerging pulpotomy materials among Nigerian paediatric dentists.

MATERIALS AND METHODS

Study design: This study was a cross-sectional survey using a self-administered questionnaire via google form.

Study location: The study was carried out across the six geopolitical zones in Nigeria where qualified paediatric dentists and those in training reside.

Study population: The study population consisted of resident doctors (registrars and senior registrars) and consultants in Paediatric Dentistry specialty practicing within Nigeria.

Study duration: This study was carried out over a period of 6 months.

Sample selection and method: A convenience sample was used consisting of all registered Paediatric Dental residents (registrars and senior registrars), and consultants still practicing in Nigeria. A comprehensive list of all trainees and consultants and their contacts was gotten from the national body, the Nigerian Association of Paediatric Dentistry. A structured online questionnaire via google form was sent via WhatsApp monthly from July 2024 till October 2024 in which participants were asked to fill the google form after giving an online informed consent.

Data collection: The questionnaire used was a modification of that used by Hingston et al. (2007) in a similar study. It included questions on the following subjects; use of the vital pulpotomy technique for primary molars; use of preoperative and follow-up assessment radiographs; use of local anaesthesia; choice of pulpotomy agent; choice of restorative material for definitive restoration of molars treated by vital pulpotomy; and • management of failures. Other questions were on concerns about preferred pulpotomy agents, willingness to use safer agents and knowledge of natural pulpotomy medicaments.

Data analysis: Data analysis was performed using Microsoft excel 2021 and SPSS version 23. Data was expressed in charts and tables and frequencies were gotten. Statistical significance was set at P value < 0.05.

Ethical approval: Before commencement of the study, ethical approval was gotten from the Health Research and Ethics Committee of the University of Benin Teaching Hospital (ADM/E 22/A/VOL.VII/1483011210048). An online informed consent was gotten from all participants and only those who gave informed consent participated in the study.

RESULTS

Sociodemographic characteristics of participants

A total of 78 google forms were sent out to members of the Nigerian Association of Paediatric Dentistry, only 49 participants responded, giving a response rate of 62.9%. Table 1 gives a summary of the sociodemographic characteristics of the study population. The study population consisted of 13 males (26.5%) and 36 females (73.5%). The population was made up of specialists (40.8%), senior registrars (26.5%) and registrars (32.7%). Most of the study participants had been in practice for either 5-10 years (28.6%) or 11-15years (26.5%), with those who had practiced for less than 5years constituting the least at 8.2%. (Table 1)

Table 1: Sociodemographic characteristics of participants

Variable	Frequency (n)	Percentage (%)
Gender		
Male	13	26.5
Female	36	73.5
Total	49	100
Cadre		
Specialist	20	40.8
Senior registrar	13	26.5
Registrars	16	32.7
Total	49	100.0
Years of Practice		
< 5	4	8.2
5-10	14	28.6
11-15	13	26.5
16-20	7	14.3
21-25	6	12.2
>25	5	10.2
Total	49	100.0

Practice of vital pulpotomy.

Forty-eight participants (98%) practiced vital pulpotomy in primary teeth. Lack of cooperation by the children and poor success rates was cited as reason for not performing pulpotomy by one participant (2%) who did not practice vital pulpotomy in primary teeth.

Pre operative radiographs were done by all respondents who practiced vital pulpotomy however, post operative radiographs were routinely done by only eighteen participants (30.6%), while five respondents (10.2%) had never taken post operative radiographs. Use of topical and infiltration of local anaesthesia was preferred by all respondents. The most favoured pulpotomy medicament was formocresol, used by thirty-five (71.4%) respondents, followed by calcium hydroxide among 7(14.3%) respondents, ferric sulphate in 4(8.2%) respondents and MTA among 3(6.1%) respondents. Only 17 (34.7%) participants used glass ionomer cement and stainless-steel crowns as final restorative material following pulpotomy, while one (2%) participant used amalgam and a combination of GIC with composite respectively.

A pulpectomy procedure was preferred by 42 (85.7%) respondents in cases of failure of pulpotomy treatment, while 6 (12.3%) preferred to re-treat the tooth, 8 (16.3%) preferred to extract the tooth. Note that answers were not mutually exclusive as respondents choose more than one treatment option in cases of failure.

Safety of pulpotomy medicament

More than half of the participants 33 (67.3%) expressed concerns about the use of their preferred pulpotomy medicament, of these, 22 (62.9%) who used formocresol expressed concerns on safety and toxicity, while 6 (17.1%) expressed concerns on mutagenicity and carcinogenicity. Majority (77.6%) of study participants expressed willingness to use a safer pulpotomy agent if available. Table 2 shows medicaments used in vital pulpotomy and the concerns raised. There was no statistically significant difference between cadre of participants and choice of medicaments, concerns or willingness to use a safer agent.

When association between years of practice and concerns about preferred pulpotomy medicament, choice of medicament and willingness to use a safer agent was checked, no significant association was observed between years of practice and concerns about preferred medicament (p-value = 0.095), choice of medicament (p-value = 0.100) and willingness to use safer agent (p value = 0.181). This is shown in table 3

Newer pulpotomy medicaments

Twenty-nine (59.1%%) respondents were unaware of natural pulpotomy medicaments as newer agents for pulpotomy. Among the participants who demonstrated awareness of natural agents, aloe vera was the most common agent mentioned among 18(45%) respondents, followed by honey in 16 (40%) and propolis in 15(37.5%). It should be noted that answers were not mutually exclusive; some dentists reported awareness of more than one agent. Thirty-four (67.3%) respondents expressed willingness to use a natural pulpotomy medicament if available, while 13(26.5%) were undecided. There was no association between cadre and years of practice and knowledge of natural pulpotomy medicaments and willingness to use natural agents. Table 4 shows knowledge of natural pulpotomy medicaments among participants.

Table 2: Medicaments used for vital pulpotomy and concerns raised.

Agents	n(%)	Concerns raised (n)
Formocresol	35 (71.4)	Safety and toxicity (22)
		Mutagenicity and carcinogenicity (6)
Ferric sulphate	4 (8.2)	Availability (1)
Calcium hydroxide	7 (14.3)	Availability (1)
		Root resorption (2)
Mineral trioxide aggregate	3 (6.1)	Availability (1)
		Costly and short shelf-life (1)
		Stains teeth (1)

Table 3: Association between cadre and years of practice with choice of medicament, concerns about preferred medicament and willingness to use a safer agent

Variable	Preferred pulpotomy medicament					Concerns about preferred medicament			Willingness to use safer agent			
	Formocresol n(%)	Ferric sulphate n(%)	$Ca(OH)_2$ n(%)	MTA n(%)	p value	Yes n(%)	No n(%)	p value	Yes n(%)	No n(%)	Maybe n(%)	P value
Cadre												
Specialist	12(60.0)	3(15.0)	2(10.0)	3(15.0)	0.132	11(55.0)	9(45.0)	0.245	15(75.0)	1(5.0)	4(20.0)	0.756
Senior Registrar	12(92.3)	0(0.0)	1(7.7)	0(0.0)		9(69.2)	4(30.8)		11(84.6)	0(0.0)	2(15.4)	
Registrar	11(68.8)	1(6.2)	4(25.0)	0(0.0)		13(81.2)	3(18.8)		12(75.0)	0(0.0)	4(25.0)	
Years of Practice												
<5	2 (50.0)	1(25.0)	1(25.0)	0(0.0)	0.100	2(50.0)	2(50.0)	0.095	2(50.0)	0(0.0)	2(50.0)	0.181
5-10	11 (78.6)	0(0.0)	3(21.4)	0(0.0)		13(92.9)	1 (7.1)		13(92.9)	0(0.0)	1(7.1)	
11-15	10(76.9)	2(15.4)	1 (7.7)	0(0.0)		6(46.2)	7(53.8)		11(84.6)	0(0.0)	2(15.4)	
16-20	7(100.0)	0 (0.0)	0 (0.0)	0 (0.0)		6(85.7)	1(14.3)		5(71.4)	0(0.0)	2(28.6)	
20-25	3(50.0)	1(16.7)	1(16.7)	1(16.7)		3(50.0)	3(50.0)		4 (66.7)	0(0.0)	2(33.3)	
>25	2(40.0)	0(0.0)	1(20.0)	2(40.0)		3 60.0)	2(40.0)		3(60.0)	1(20.0)	1(20.0)	

Table 4: Knowledge of natural pulpotomy medicaments

Natural medicament	Number (%)
Aloe vera	18 (45)
Propolis	15 (37.5)
Turmeric powder	8 (20.0)
Honey	16 (40.0)
Garlic oil	7 (17.5)

DISCUSSION

This cross-sectional study was carried out to assess the current practice of vital pulpotomy and the knowledge of emerging pulpotomy medicaments among Nigerian paediatric dentists. Pulpotomy is considered one of the commonest treatment procedures carried out in paediatric dental clinics for the treatment of dental caries sequalae, however, there appears to be an age long controversy among Dentists on the ideal medicament to be used (Chandrashekhar & Shashidhar, 2014; Smail-Faugerson *et al.*, 2018). Our study reveals that formocresol is still the most commonly used medicament for pulpotomy among Nigerian paediatric Dentists, a finding which is in keeping with established findings in literature (Waterhouse, 1995; Goyal & Indushekar, 2013). Calcium hydroxide was the second commonly used medicament and was noted in 14% of the study population. This is a rather interesting as most literature discourage the use of calcium hydroxide in primary molars due to its association with root resorption (Alaçam *et al.*, 2009; Bagchi *et al.*, 2021), a concern raised by only a third of participants in our study. While MTA and ferric sulfate were the most preferred alternatives to formocresol (Fuks, 2002; Srinivasan *et al.*, 2006), their use by participants in our study was noted to be limited, a finding which may be related to the availability and cost of these materials. The

persistent use of traditional materials despite well documented concerns may be attributed to familiarity, affordability and long-standing clinical success. In resource-limited settings like Nigeria, cost-effectiveness and availability often outweighs newer evidence which may explain continued use among participants.

A uniformity of practice was noted in use of anaesthesia, and pre-operative radiograph among all participants, however there was observed variation in practices in restorative materials, post operative radiographs and options in case of failure. Various materials were noted to be used among our respondents including amalgam, glass ionomer cement, stainless steel crowns and composite. Only two thirds of respondents reported use of stainless-steel crown which is considered the gold standard and the most reliable and durable restorative material for pulpotomized primary molars (Kaur *et al.*, 2023). Its use in the paediatric population may however be affected by aesthetic concerns by parents due to its silver colour. While certain research suggest use of intra-coronal restorations like glass ionomer cement and composite restorations in cases of caries affecting one surface only with presence of enough tooth structure for retention (American Academy of Pediatric Dentistry, 2020), our study did not assess the use of restorative materials in relation to number of carious surfaces; hence it is difficult to judge the reason for the varied use of restorative materials. Variations were also noted on exposure of post operative radiographs. Although literature clearly states the importance of post-operative radiographic evaluation and follow up of the pulpotomized primary molar (Hunter & Hunter, 2003), less than a third of the study population routinely took post-operative radiographs with 59% doing so sometimes and 10% had never done post operative radiographs. The reason for this finding cannot readily be ascertained by the authors. Treatment options in cases of failure ranged from a retreatment to pulpectomy to extractions. This is understandably so as there are no clear guidelines in literature in cases of failure of pulpotomy treatment in primary molars hence a case-by-case assessment would be necessary to make a treatment choice.

An expected finding which is in consonant with established literature was the expression of concern on use of formocresol and willingness to use safer agents if available. Recent findings and literature strongly discourage the use of formocresol for pulpotomy in primary teeth due to its questionable safety and toxicity as well as its suspicion for mutagenicity and carcinogenicity thus, resulting in the search for safer and readily available options (Fuks *et al.*, 2012; Hugar *et al.*, 2017). The variation in practice of pulpotomy in primary teeth in relation to the choice of medicaments, exposure of post-operative radiographs, restorative materials and treatment options in cases of failure among Nigerian Paediatric Dentists noted in our study highlights a lack of uniformity in clinical decision-making among Nigerian paediatric dentists, and may reflect differences in training background, years of clinical experience, availability of materials and institutional protocols.

In recent times there has been a shift towards natural agents with various studies highlighting their use having comparable results to established medicaments (Kumari *et al.*, 2017; Purohit *et al.*, 2017; Gomaa & Allam, 2020). Our study showed a low awareness of natural pulpotomy medicaments among paediatric Dentists in Nigeria with only 40.9%% showing awareness. In contrast two thirds of the study population were willing to use a natural pulpotomy medicament if available while 22.4% were undecided. This indicates a positive attitude towards innovation and evidence-based practice suggesting that primary barriers are not resistance to change, but rather external constraints such as cost, availability and lack of continuing training.

Some of the limitations of this study include, firstly, the study was a self-reported questionnaire based cross sectional study and may be limited by potential recall bias. Secondly the sample size for this study is small. Although questionnaires were sent to all practicing paediatric Dentists in Nigeria as at the time of this study, the response rate was 62.9% with only 49 respondents, hence caution should be exercised in generalizing findings as true opinions of all paediatric Dentists in the country. Lastly the study did not assess some aspects of clinical practice such as the location of practice and method of isolation, factors which may be important in the practice of pulpotomy.

Overall, this study provides valuable national data on pulpotomy practice among paediatric dentists in Nigeria and informs the need for standardized clinical guidelines, improved undergraduate and postgraduate training and targeted continued professional training on emerging materials and best practices, while also informing policymakers and hospital administrators about the need to improve access to pulpotomy materials for paediatric dental patients in Nigeria.

CONCLUSION

This study highlights that pulpotomy remains a widely practiced and essential procedure in management of primary molars among Nigerian Paediatric Dentists, with varying practices and knowledge of emerging materials. Standardization of pulpotomy protocols and continuing education on newer materials are essential to optimize treatment outcomes.

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QUESTIONNAIRE

This questionnaire assesses the attitude and practice of Paediatric Dentist practicing in Nigeria on Vital pulpotomy in deciduous molars.

Note that it is voluntary and you can choose to participate or otherwise.

If you would like to continue, kindly click the box [ ]

Biodata

Age: < 25years [ ] 25-30 [ ] 30-35[ ] 35-40 [ ] 40-45 [ ] 45-50[ ] >50years [ ]

Sex: Male [ ] Female [ ]

Cadre:Consultant [ ] Senior registrar [ ] Registrar [ ]

Years of practice: <5 [ ] 5-10[ ] 11-15 [ ] 16-20 [ ] 21-25[ ] >25[ ]

Attitude and practice

1. Do you use vital pulpotomy in management of primary molars? Yes [ ] No[ ]

2. If answer to the above is no, what are your reasons.....
.....
.....

3. If yes, are pre-operative radiographs taken before start of the procedure? Always [ ] sometimes [ ] Never [ ]

4. What type of anaesthesia do you use? Topical only [ ] topical and infiltration/spray [ ] no anesthesia [ ]

5. What pulpotomy agents do you use commonly? Formocresol [ ] ferric sulphate [ ] calcium hydroxide [ ] MTA[ ] others (please state) .....

6. Do you have concerns about your commonly used pulpotomy agent? Yes[ ] no[ ]

7. If yes to question 6, what are your concerns?
A.....
B.....
C.....
D.....

8. If a safer pulpotomy medicament is available would you be willing to stop using your preferred pulpotomy medicament? Yes [ ] No [ ] I don't know [ ]

9. You aware of natural agents for pulpotomy medicaments? Yes [ ] No[ ]
10. Which of these agents can be used as natural pulpotomy medicaments? (you can tick more than one)
Aloe vera [ ] Propolis[ ] Turmeric powder[ ] Honey[ ] Garlic oil [ ]
11. Will you be willing to use a natural pulpotomy agent if available? Yes [ ] no[ ]
12. Do you routinely take post operative radiographs after pulpotomies? Always [ ]
Sometimes [ ] never[ ]
13. What is your preferred restorative material after pulpotomy?
Amalgam [ ] composite [ ] GIC filling [ ] stainless steel crowns [ ] Other(please state).....
14. In case of failure of pulpotomy what is your preferred treatment option?
Re- pulpotomy [ ] pulpectomy [ ] extraction [ ] others(please
state).....