



ORIGINAL ARTICLE

A retrospective study of sodium hypochlorite pulpotomies in primary molars



Tzu-Ying Li ^a, Li-Chuan Chuang ^{b,c*}, Aileen I. Tsai ^{b,c}

^a Department of Pediatric Dentistry, Chang Gung Memorial Hospital at Taoyuan, Taoyuan, Taiwan

^b Department of Pediatric Dentistry, Chang Gung Memorial Hospital at Linkou, Taoyuan, Taiwan

^c Graduate Institute of Craniofacial and Dental Science, College of Medicine, Chang Gung University, Taoyuan, Taiwan

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Abstract *Background/purpose:* Formocresol has been a popular pulpotomy medicament for primary molars, however, its toxicity and potential carcinogenicity leaves room for other alternatives such as sodium hypochlorite (NaOCl). The purpose of this study is to evaluate the clinical and radiographic success rate of 5% NaOCl pulpotomy in primary molars.

Materials and methods: A retrospective research of patient records from January 1, 2009 and December 31, 2012 was conducted to evaluate the clinical and radiographic success rate of 5% NaOCl pulpotomy in primary molars.

Results: A total of 147 NaOCl primary molar pulpotomies in 52 patients were included in the study. Clinical success rates at 6 months, 12 months, and 24 months were 100%, 97%, and 97%, respectively. Radiographic success rates at 6 months, 12 months, and 24 months were 99%, 89%, and 77%, respectively. Internal root resorption was the most common radiographic pathologic finding.

Conclusion: The clinical and radiographic success rate for NaOCl pulpotomies is comparable with formocresol and ferric sulfate pulpotomy success rates reported in previous studies.

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Introduction

Pulpotomy is an accepted procedure for treating carious exposed pulps in symptom-free primary molars. Formocresol (FC) was first introduced by Sweet in 1932,¹ and has been a popular medicament in pulpotomy procedure, mainly due to its ease of use and clinical success. However, concerns about the appropriateness and safety of FC have

* Corresponding author. Department of Pediatric Dentistry, Chang Gung Memorial Hospital at Linkou, Number 5, Fusing Street, Gueishan Township, Taoyuan County 333, Taiwan
E-mail address: soleus34@adm.cgmh.org.tw (L.-C. Chuang).

been raised; there have been reports of toxicity,² post-operative systemic transport,³ potential carcinogenicity,⁴ negative radiographic changes in treated teeth,⁵ and negative effects on succedaneous tooth enamel.⁶

The International Agency for Research on Cancer classified formaldehyde as carcinogenic in humans in June 2004,⁷ leaving the profession to look for alternatives to FC. Presently, there are several pulp dressing medicaments that have been proposed as replacements for FC, including: electrosurgery,⁸ laser,⁹ glutaraldehyde,¹⁰ calcium hydroxide,¹¹ freeze-dried bone,¹² bone morphogenetic protein,¹³ osteogenic protein,¹⁴ ferric sulfate (FS),¹⁵ mineral trioxide aggregate (MTA),¹⁶ and sodium hypochlorite (NaOCl).¹⁷

Some medicaments, such as MTA, have presented better results than FC. However, MTA has a high cost and is more difficult to operate. NaOCl has been used as an irrigant agent in root canal treatments for permanent teeth since the 1920s,¹⁸ and has been shown to have good antimicrobial effects without being a significant pulpal irritant.¹⁹ Rosefeld et al²⁰ showed that placement of 5% NaOCl on non-instrumented vital pulp tissue acted only at the superficial surface, with minimal effects on deeper pulpal tissue. Hafez et al^{21,22} showed normal soft tissue reorganization and dentinal bridge formation after hemorrhage control was obtained with 3% NaOCl in pulpotomized adult monkey teeth. By contrast, significant pulpal necrosis was found with FC.

As a result of previous studies, we have used 5% NaOCl as pulpotomy medicament since January 1, 2009. The aim of this retrospective study was to evaluate the clinical and radiographic success rate of 5% NaOCl pulpotomy in primary molars during a 4-year period and followed for 6 months, 12 months, and 24 months.

Materials and methods

Participants

Following approval from the Institution Review Board of Chang Gung Memorial Hospital (103-4833B), a search of patient records was conducted for the time period between January 1, 2009 and December 31, 2012, to identify all primary tooth pulpotomy procedures. Patient records were included in the study based on the following criteria: (1) healthy children without any systemic disease (between 2 and 6 years old during pulpotomy therapy); (2) not taking long-term antibiotics; (3) at least one primary molar with NaOCl pulpotomy therapy and stainless steel crown restoration; (4) before NaOCl pulpotomy therapy, the sample tooth must not have any clinical symptoms of spontaneous pain, mobility, gingival swelling, tenderness to percussion, and unsuccessful hemorrhage control; and (5) before NaOCl pulpotomy therapy, the sample tooth must not have any radiographic signs of internal root resorption, external root resorption, furca radiolucency, and widened periodontal ligament space.

Treatment

A rubber dam was placed on the treated teeth. Caries were removed and pulp chambers opened using a diamond round

#440 bur (Brasseler USA, Savannah, GA, USA) in a high-speed hand piece (KaVo Dental Corp, Lake Zurich, IL, USA) with water coolant. Pulp amputation was performed using a #8 round bur (Brasseler USA) in a slow-speed hand piece (KaVo Dental Corp). Orifices were visually inspected for complete removal of the pulp tissue. Hemorrhage control was obtained within 5 minutes by applying light pressure to dry, sterile cotton pellets placed over the pulpal stumps. Following hemostasis, a cotton pellet soaked in 5% NaOCl was placed in the chamber for 30 seconds. The pellet was removed, and the pulp chamber was filled with zinc oxide-eugenol (ZOE) with polymer reinforcement (IRM[®], Dentsply Caulk, USA).²³ The tooth was restored with a stainless steel crown (SSC) (3M/ESPE, St. Paul, MN, USA) cemented with glass ionomer cement (Ketac-Cem; 3M/EPSE).

Follow up

Clinical and radiographic evaluations based on criteria by Smith et al²⁴ and Vargas et al,¹⁷ were performed over 6 months, 12 months, and 24 months. The sample teeth chosen for the chart had both clinical and radiographic findings; teeth without such findings were excluded from our study. The clinical examination was performed by the principal investigator.

Clinical success was defined by: (1) no spontaneous pain; (2) restoration intact; (3) no mobility; (4) no swelling; and (5) no fistula. Radiographic success was defined by: (1) no external root resorption; (2) no internal root resorption; and (3) no interradiacicular bone destruction. All radiographs with good qualities were read by three examiners who were blinded to the clinical results and the kappa values were 0.83–0.87 and 0.95–0.98 for interexaminer and intra-examiner reproducibility. If a discrepancy occurred between radiographic results, consensus was reached by discussion.

Data recorded from each chart included: (1) identity of tooth/teeth treated; (2) clinical and radiographic pre-treatment condition of tooth; (3) date of treatment; (4) date of follow up(s); (5) clinical condition of pulpotomized tooth at follow up; and (6) postoperative radiographic findings.

Results

A total of 147 NaOCl primary molar pulpotomies in 52 patients were completed between January 1, 2009 and December 31, 2012 at Chang Gung Memorial Hospital at Linkou. All 147 teeth had 6-month data, 129 teeth had 12-month data, and 62 teeth had 24-month data. All teeth had adequate coronal seals. If the SSC were not intact, such as broken or loosening, the tooth was eliminated from the study. Once a tooth was identified as a clinical or radiographic failure, it was no longer included for further evaluation in the next period.

Clinical findings

All 147 primary molars were asymptomatic in clinical evaluation at the 6-month follow up (Table 1). Of the 129 teeth followed for 12 months, four teeth were clinical

failures. Spontaneous pain ($n = 1$), abscess ($n = 1$), and mobility ($n = 2$) were noted in the chart. Over the next 24 months, two of the 62 teeth had abscesses on the buccal mucosa. Clinical findings revealed that the success rate decreased over time.

Radiographic findings

At the 6-month follow-up period, only one tooth (1/147) had external root resorption combined with internal root resorption. At the 12-month recall, 89% (115/129) were radiographically successful (Table 1). Internal root resorption ($n = 9$) was the most common pathologic change, followed by interradicular bone destruction ($n = 4$). External root resorption ($n = 2$) and other abnormalities ($n = 2$) were also noted. At the 24-month recall, the radiographic success rate was 77% (48/62); internal root resorption ($n = 12$) was still the most common pathologic change. Some teeth demonstrated more than one pathologic change. Radiographic findings revealed that success rate decreased over time.

Discussion

This retrospective 5% NaOCl pulpotomy study demonstrates that the clinical success rates at 6 months, 12 months, and 24 months were 100%, 97%, and 97%, respectively; the radiographic success rate at 6 months, 12 months, and 24 months were 99%, 89%, and 77%, respectively. A similar retrospective study of NaOCl pulpotomies in primary molars was evaluated by Vostatek et al.²⁵ A total of 131 primary molars from 77 children were available for follow-up examinations (3–21 months). NaOCl pulpotomies had a 95% clinical and 82% radiographic success rate. External root resorption was the most common pathologic finding. Another study by Vargas et al.¹⁷ reported that 5% NaOCl had favorable results compared with FS as a pulpotomy medicament. At 6 months, 100% clinical success was found in both the FS and NaOCl groups. Radiographic success for FS was 68%, with internal resorption being the most common finding. The NaOCl showed 91% radiographic success. At 12 months, FS had 85% clinical success and 62% radiographic success. NaOCl had 100% clinical success and 79% radiographic success. The authors concluded that NaOCl was superior to FS as a pulpotomy medicament in primary

molars. They presented NaOCl success rates comparable with FC and FS pulpotomies reported in the literature.²⁵

A randomized study comparing 3% NaOCl with 1:5 dilution of Buckley's FC pulpotomy by Ruby et al.²⁶ revealed no significant difference on both groups. FC and NaOCl groups demonstrated 100% clinical success at 6 months and 12 months. The NaOCl group had 86% radiographic success at 6 months and 80% at 12 months. The FC group had 84% radiographic success at 6 months and 90% at 12 months.²⁶ Another randomized study comparing 5% NaOCl and 20% FC by Al-Mutairi and Bawazir²⁷ also revealed no significant difference on both groups. At 6 months, NaOCl showed 95% and 87.5% clinical and radiographic success rate, respectively, while FC showed 95% clinical and radiographic success rate. After 12 months, the clinical and radiographic success rates were 94.6% and 86.5% for NaOCl, and 92.1% and 86.8% for FC.²⁷ Comparing previous studies of NaOCl pulpotomy with our study, we see similar success rates. The clinical success rates at 6 months, 12 months, and 24 months were 95–100%, 94–100%, and 97%, and the radiographic success rates at 6 months, 12 months, and 24 months were 87–99%, 79–89%, and 74–77%, respectively (Table 2).

Many studies have evaluated the use of FS compared with FC. Several retrospective and prospective studies have shown equivalent results in primary molar pulpotomy procedures.^{15,24,28} The clinical success rates in previous studies of FC and FS have ranged from 83–100% and 89–100%, respectively. The radiographic success rates were 73–100% for FC and 74–97% for FS. Our results for NaOCl pulpotomies also fall within the range of these published data.

The most common pathologic findings reported in the previous study for pulpotomized primary teeth treated with FC and FS are internal root resorption and interradicular bone destruction. Some teeth demonstrated more than one reportable pulpal response over time.^{24,28} The current study is consistent with the literature.

Smith and coworkers²⁴ pointed to ZOE as the cause of pulpal inflammation (and resulting in internal root

Table 1 Sodium hypochlorite pulpotomy success rate.

	6 mo	12 mo	24 mo
Clinical			
Success	147 (100)	125 (97)	60 (97)
Failures	0 (0)	4 (3)	2 (3)
Total	147 (100)	129 (100)	62 (100)
Radiographic			
Success	146 (99)	115 (89)	48 (77)
Failures	1 (1)	14 (11)	14 (23)
Total	147 (100)	129 (100)	62 (100)

Data are presented as n (%).

Table 2 Comparison of sodium hypochlorite pulpotomy success rate in different studies.

Success rate (%)	Clinical			Radiographic		
	6 mo	12 mo	24 mo	6 mo	12 mo	24 mo
Vargas et al. ¹⁷ 5% NaOCl	100	100	NA	91	79	NA
Ruby et al. ²⁶ 3% NaOCl	100	100	NA	86	80	NA
Al-Mutairi and Bawazir ²⁷ 5% NaOCl	95	94.6	NA	87.5	86.5	NA
Vostatek et al. ²⁵ 5% NaOCl	NA	95 ^a	97 ^b	NA	85 ^a	74 ^b
Present study 5% NaOCl	100	97	97	99	89	77

NA = not available.

^a 3–12 months.

^b 13–21 months.

resorption). They speculated that the fixative properties of FC created a barrier against some of eugenol's irritating properties, while the clotting characteristics of FS were not as effective at producing such a barrier. Perhaps the hemorrhage-controlling properties of NaOCl (like FS) also do not produce a necrosis layer (like FC).

The pulpotomies evaluated in the previous study were completed by multiple operators.^{25,28} Thus, the lack of consistency in techniques and initial diagnosis in case selection is an obstacle to these results. For this reason, the pulpotomy procedure in our study was performed by one attendant. Furthermore, all procedures were performed under general anesthesia to avoid patient interference.

The radiographic success rate was lower than the clinical success rate. Some teeth with pathological changes were asymptomatic clinically. However, pathological findings may be detected over time. Certain previous studies with a shorter follow-up period could not reveal the initial pulpal response.^{17,26,27} In the present study, teeth were post-operatively observed multiple times to reflect multiple observations of the same tooth over time. Previous investigations suggested that failures were the result of inadequate coronal seals.^{21,29} It was necessary that the teeth in our study have intact restorations.

Clinical and radiographic findings of NaOCl pulpotomy success decreased over time. Before using NaOCl pulpotomy for primary molars in very young children, one should consider the chance of failure increasing over time. Other pulp therapies with high success like MTA pulpotomy (100% clinical success rate and 94.4–100% radiographic success rate at 24 months^{30,31}) are preferred because they prolong the primary molar survival period in very young children.

The reasons for high dropout rate during the 2-year follow-up period were the reluctance of parents to participate in long-term follow up, the exfoliation of sample teeth, and uncompleted clinical or radiographic findings.

Because no comparable control group was utilized during the same period, in the future, we can design a prospective, randomized, doubled-blinded clinical trial where two or more pulpotomy techniques could be compared.

In conclusion, clinical and radiographic success rates for NaOCl pulpotomies in this study are comparable with FC and FS pulpotomies reported in previous studies with equivalent follow-up intervals. Clinical and radiographic findings of NaOCl pulpotomy success decreased over time. Internal root resorption was the most common pathologic finding in the radiographs. These results can provide valuable information for future clinical references.

Conflicts of interest

The authors have no conflicts of interest relevant to this article.

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