Radiographic Assessment of Primary Molar Pulpotomies Restored With Resin-based Materials

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Abstract

Purpose: The aims of this study were to: (1) retrospectively assess the overall performance of formocresol pulpotomies in primary molars when definitively restored with a resin-based material; and (2) compare the results to previously published studies using more traditional restorative techniques (stainless steel crown, amalgam).

Methods: Records of a 2-operator pediatric dental office using this novel restorative technique were reviewed. Pre- and postoperative radiographs of pulpotomized primary molars restored with Z-100 and with a minimum of 6 months of follow-up were compared to the contralateral nonpulpotomized tooth. Radiographic success was determined by the absence of furcation/periapical osseous radiolucency and internal/external pathologic root resorption. Patient's age, gender, tooth type and arch, follow-up time, ZOE base type used (IRM only or IRM with glass ionomer overlay), and number of surfaces involved were the variables analyzed in the study. Statistical analysis was performed using chi-square analysis.

Results: Fifty-nine teeth in 52 patients met the selection criteria. Patient's age at treatment ranged between 44 and 118 months, with an average follow-up time of 21 months (range=7 to 43). Significant failure rate was found in the mandibular arch (P=.035). When only the occlusal surface was restored, 100% success was obtained. With proximal restorations, 83% (15/18) success was obtained when the base was IRM followed by glass ionomer and 69% (22/32) success for IRM only (P=.259).

Conclusions: Overall, restoration of pulpotomized primary molars with resin-based material was inferior to reported success rates using stainless steel crowns. When proximal surfaces were restored, the failure rate (26%) was comparable to amalgam (23%). Prospective studies with larger sample size are necessary for definitive conclusions. (*Pediatr Dent.* 2005;27:24-27)

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Pulpotomy is the recommended procedure to treat infected coronal pulps in primary teeth.[1] This procedure involves:

1. removal of the coronal pulp tissue;
2. application of a pulp medicament over the radicular pulp tissue, most commonly formocresol;[1]
3. restoration of the tooth.

This restoration is performed in 2 steps:

1. Zinc oxide-eugenol (ZOE) base material fills the coronal pulp chamber.
2. Permanent restorative material is placed over the base.

Traditionally, stainless steel crowns (SSCs) have been recommended as the restoration of choice to protect pulpotomized teeth from fracture.[2,3] Although very effective, these restorations are esthetically unpleasant. A recent long-term study of veneer facing primary molar SSCs demonstrated very poor esthetic results, with chipping of the facing in all crowns after 4 years in function.[4]

Esthetic concerns are often expressed by parents after SSC placement on children's teeth and the need for a more esthetic alternative is evident.[5,6] The success of amalgam restorations to restore pulpotomized primary molars was previously reported,[7] but the esthetic problem was not addressed.

Nonmetal, resin-based materials are acceptable restorative materials for the restoration of primary molars and very popular among pediatric dentists.[8,9] A technique to restore

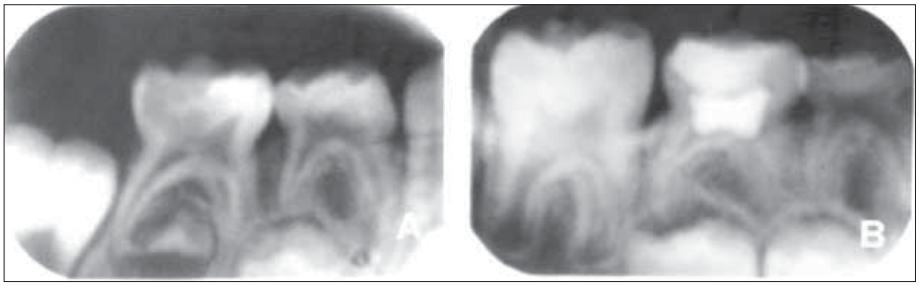

Figure 1A. Preoperative radiograph of a 51-month-old male showing deep occlusal decay on the primary mandibular right second molar.
Figure 1B. Postoperative radiograph after pulpotomy using IRM+Z100 at 14 months follow-up.

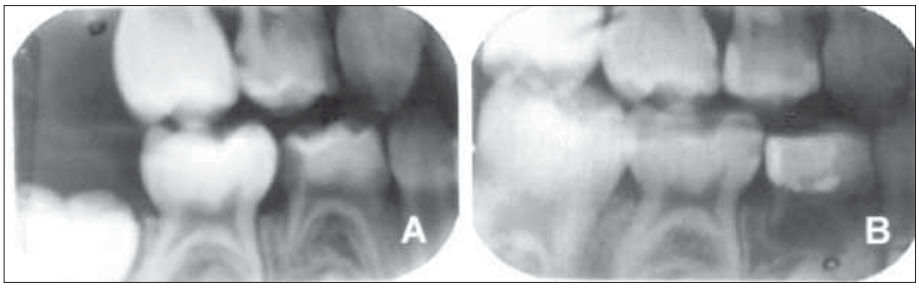

Figure 2A. Preoperative radiograph of a 65-month-old female showing deep proximal decay on the primary mandibular right first molar.
Figure 2B. Postoperative radiograph after pulpotomy using IRM+Z100 at 23 months follow-up.

pulpotomized primary molars using glass ionomer and resin-based materials (sandwich technique) over a thin layer of zinc oxide eugenol was suggested by Berg and Donly.[10] Although no controlled clinical trials were performed, this technique was indicated for primary molars without extensive tooth destruction and having at least 2 walls remaining prior to restoration. El-Kalla and García-Godoy demonstrated in vitro that bonded resin-based materials increased the fracture resistance of a pulpotomized tooth.[11]

The aims of this study were to:

1. retrospectively assess the radiographic success of formocresol pulpotomies in primary molars when definitively restored with a resin-based material;
2. compare the results to previously published studies using other restorative materials (SSCs and amalgam).

Methods

This study's investigators identified a pediatric dental office in Tampa, Fla, that for several years had been routinely using resin-based materials to restore pulpotomized primary molars. That office agreed to participate in the study, allowing the review of their patients' records. The study was reviewed and approved by the Institutional Review Board of the University of Florida, and a waiver of informed consent for records' review was granted.

The studied teeth were treated by 2 board-eligible, experienced operators as part of a standard quadrant dentistry approach under rubber dam isolation with and without nitrous oxide inhalation. No treatment was performed under sedation. The pulp medicament used for 1 to 5 minutes was diluted formocresol. One operator restored the pulp chamber with only reinforced ZOE (IRM—Dentsply Caulk, Mildford, Del), while the second one used IRM covered by a layer of glass ionomer (Vitrebond, 3M Espe, St. Paul, Minn). After total-etch and bonding (Single Bond, 3M Espe, St. Paul, Minn), a resin-based material—Z100 (3M Espe, St. Paul, Minn)—was incrementally packed, with 30 seconds curing time for each increment. A metal matrix and wooden wedge were utilized when proximal surface restorations were performed.

The investigator periodically visited the dental office to obtain the data from a standardized chart review. Only restored teeth that had been in function in the mouth for at least 6 months were included. Preoperative radiographs (bitewings and periapicals) and the most recent postoperative radiographs were: (1) digitally photographed; (2) projected into a 17" computer screen; and (3) analyzed by 2 investigators.

The radiographs of pulpotomized primary molars were compared to the contralateral nonpulpotomized (control) teeth to assess exfoliation rate (normal, accelerated, or delayed). The control teeth were caries free or had small Class I or Class II resin-based restorations not approaching the pulp. Radiographic success criteria were determined by:

1. the absence of furcation/periapical osseous radiolucency;
2. internal/external pathologic root resorption (pathologic failure).

Figure 3. Success of pulpotomies as a function of follow-up time.

Table 1. Outcomes by Study Factors

Outcome	Age (ys)		Gender		Tooth type		Arch	
	<6	>6	Male	Female	1st molar	2nd molar	Maxilla	Mandible
Success (%)	12(67)	34(83)	26(84)	20(71)	28(61)	11(85)	22(92)	24(68)
P value	.165		.628		.110		.035*	
Failure	6	7	5	8	18	2	2	11

*Statistically significant (chi-square).

Table 2. Outcomes (% of Success) by Number of Surfaces Versus Type of Base

	Type of base		
No. of surfaces	IRM	IRM+glass ionomer	Total
1 (occlusal only)	7/7(100%)	2/2(100%)	9/9(100%)
2 (proximal and occlusal)	22/32(69%)	15/18(83%)	37/50(74%)
Total	29/39(74%)	17/20(85%)	46/59(78%)

Radiographic success criteria was assessed according to Holan et al.[7] The variables analyzed were: (1) patient's age; (2) gender; (3) tooth type and arch; (4) follow-up time; (5) base type used under final restoration; and (6) number of surfaces involved. In addition, the records' written notes were reviewed to detect any clinical observations during recall visits such as sensitivity and any negative outcomes such as loss of restoration, need for replacement, and extraction. Chi-square analysis was used to calculate the effect of different variables on the treatment outcome.

Results

Fifty-nine teeth in 52 patients met the evaluation criteria. Patients' age at treatment varied between 44 and 118 months (mean age=81 months), with an average follow-up time of 21 months (range=7 to 43). A significant failure rate was found in the mandibular arch (*P*=.035). When only the occlusal surface was restored, 100% success was obtained (Figure 1). For the type of base placed with proximal restorations (Figure 2), 83% (15/18) success was obtained when IRM and Vitrebond were combined and 69% (22/32) success was obtained for IRM only (*P*=.259). None of the restorations needed replacement, and no postoperative sensitivity was recorded (Tables 1 and 2). Although not statistically significant (*P*=.063), a tendency toward higher failure rate was noticed when follow-up time extended beyond 24 months (Figure 3). When compared to their contralateral nonpulpotomized control teeth, the 59 pulpotomized primary molars restored with resin-based material exhibited:

1. exfoliated normal physiologic resorption patterns for 47 teeth (80%);
2. accelerated resorption for 2 teeth (3%);
3. pathologic failure for 10 teeth (17%).

Discussion

The use of diluted formocresol as a pulp medication is in agreement with the standard of care for pulpotomies in primary molars, confirming its popularity among pediatric dentists.[1,12] Traditionally, pulpotomized primary molars are restored with full-coverage SSCs that lack esthetic acceptance by parents.[5,6] Restoration with resin-based materials is worthy of investigation. The placement of resin over eugenol-containing IRM has, however, been criticized.

Until recently, placement of eugenol-containing material in cavities later to be restored with resin-based materials was not advocated. This was due to the eugenol causing inhibition of the polymerization of resin materials, leading to increased surface roughness, reduced microhardness, and decreased color stability of resin composite cured in contact with ZOE.[13,14] Numerous in vitro studies assessing the effect of eugenol-containing materials on microleakage of composite materials have been performed.[13-19]

According to Yap et al,[19] microleakage of composite restorations depends on the powder-liquid ratio of the zinc oxide eugenol cement. Their recommendation was to avoid the use of temporary restorations prior to composite placement. Contradictory results were obtained in recent studies performed under the following hypothesis: that total-etch and new bonding techniques are able to eliminate any residual temporary cement and eugenol contaminated dentin, consequently increasing wetability and insensitivity to temporary fillings with a eugenol-containing material.[20,21]

These in vitro studies concluded that eugenol-containing temporary filling materials may be used safely prior to restoration with resin-based materials.[20,21] In all studies previously cited,[13-21] IRM was used as a temporary restoration and completely removed prior to placement of the final resin restoration. No study (in vitro or in vivo) was found where zinc oxide eugenol material was left in the preparation as a base under the composite restoration, as in the present study. Nevertheless, none of the restorations needed to be replaced. The findings showed that better results were obtained when IRM was covered with glass ionomer cement (85%, 17/20) vs IRM only (74%, 29/39), but this comparison was not statistically significant (Table 2).

Holan et al[7] compared primary molar pulpotomies restored with amalgam and SSCs. Excellent results (90%, 18/20) were obtained when only the occlusal surface was restored. Although not statistically significant, when proximal

amalgam restorations were involved, the results were inferior (77%, 23/30) to teeth restored with SSCs (87%, 241/287). Compared to Holan et al,[7] similar successful results for occlusal only and proximally involved surfaces were obtained in the present study.

No reasonable explanation could be found to justify a significant failure rate in the mandible vs the maxilla. Tooth morphology and the fact that the number of mandibular teeth involved in the study was 1.5 times larger than for the maxillary teeth may have contributed to this result.

The present study was not a prospective controlled clinical trial. This may have weakened the significance of the results. Additionally, well-designed and controlled clinical trials to assess the success of ZOE-based materials with and without glass ionomer coverage prior to resin based restorations over pulpotomies are necessary to validate the authors' findings.

Conclusions

The following conclusions were drawn from this study:

1. Overall, the pulpotomy success rate for resin-based restorations (78%) was inferior to prior studies using SSCs.
2. When proximal surfaces were involved, the failure rate (26%) was comparable to that reported for amalgam restorations (23%).[7]
3. Additional studies with a larger sample size in a controlled prospective clinical trial are necessary for definitive conclusions.

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