Microleakage of Restorative Techniques for Pulpotomized Primary Molars

Marcio Guelmann, DDS Kelsey L. Bookmyer, DDS Patricia Villalta, DDS, MS Franklin García-Godoy, DDS, MS

ABSTRACT

Purpose: This study's purpose was to assess in vitro microleakage of different restorative materials after pulpotomies in primary molars.
Methods: Proximo-occlusal cavity preparations were prepared in 60 extracted primary molars. The selected teeth had at least 3 sound walls and one half to two thirds of root length remaining. Carious tissue was removed, pulpotomy was performed, and IRM filled the pulp chamber. The teeth were then randomly divided equally into 5 groups and restored as follows: (1) group 1 with a compomer; (2) group 2 with a reinforced glass ionomer material; (3) group 3 with amalgam; (4) group 4 with a stainless steel crown (SSC); and (5) group 5 with IRM only (control). After thermocycling for 500 cycles, teeth were immersed in dye for 24 hours and progressively ground prior to microleakage evaluation. The worst result for each section was logged and results were statistically analyzed (Kruskal-Wallis and Mann-Whitney).
Results: Group 1 showed the highest percentage of no leakage of all groups. Leakage from occlusal and cervical margins was markedly shown for all specimens of groups 2, 3, and 5.
Conclusions: (1) Bonding agents and resin based restorations were able to provide the best total margin protection. (2) SSCs cemented with glass ionomer cement were unable to hermetically seal teeth; and (3) Tytin, Ketac Molar, and IRM restorations did not appear to be leakage-resistant materials for pulpotomies of primary molars. (*J Dent Child*. 2004;71:209-211)

KEYWORDS: PULPOTOMY, MICROLEAKAGE, RESTORATIVE MATERIALS

Pulpotomy is considered the treatment of choice for infected coronal pulps in primary teeth.[1] This procedure involves: (1) coronal pulp tissue removal; (2) fixative agent applied over the radicular pulp tissue; and (3) restoration of the tooth. This restoration is performed in 2 steps:

1. A zinc oxide-eugenol-based material fills the coronal pulp chamber.
2. A permanent or temporary restoration is placed to restore the tooth.

Traditionally, stainless steel crowns (SSCs) have been the material of choice for restorations of pulpotomized primary molars and their success has been extensively documented.[2] The following factors may determine the use of a restorative material other than a SSC: (1) treatment conditions (emergency vs regular treatment); (2) tooth longevity; (3) financial and/or esthetic concerns.

Dr. Guelmann is assistant professor and interim chair, Department of Pediatric Dentistry, University of Florida College of Dentistry, Gainesville, Fla; Dr. Bookmyer is a pediatric dentist in private practice, Round Rock, Tex; Dr. Villalta is assistant professor, Oral Health Research Center, and Dr. García-Godoy is professor and associate dean for research, College of Dental Medicine, Nova Southeastern University, Ft. Lauderdale, Fla. Correspond with Dr. Guelmann at mguelmann@dental.ufl.edu

Irrespective of the restoration material type, treatment success depends greatly on the presence of leakage-free margins to avoid bacteria penetration and subsequent failure of the restoration and/or treatment.[3] So far, only 2 clinical studies presented results when an alternative material was used to restore primary molars after pulpotomy.[4,5]

The purpose of this in vitro study was to assess microleakage of different restorative materials after pulpotomies in primary molars.

METHODS

Sixty primary first and second molars indicated for extraction due to caries or orthodontic reasons were collected for this study. To qualify, the selected teeth needed to have at least 3 sound walls and one half to two thirds of root length. The collected teeth were cleaned with a pumice paste and a rubber prophylaxis cup and were stored in distilled water for no more than 3 months. Proximo-occlusal cavity preparations involving 2 surfaces only were made with a no. 330 high-speed bur under water coolant. Cavity size varied and depended on the extent of decay to the proximal surface, sometimes resulting in cervical margins localized at the cementoenamel-junction. Whenever no decay was present in the proximal surface, ideal

Class II preparations were made with cervical margins ending in the enamel. With completion of the cavity outline, access to the pulp chamber was gained with the same no. 330 bur. A no. 6 carbide round bur in a slow-speed handpiece completed the final convenience form of the pulp chamber exposing the canal orifices.

Teeth were then randomly divided into 5 groups of 12 teeth each. Before restoration:

1. Teeth were air dried.
2. A tofflemire matrix holder with a 0.5-mm metal matrix strip was adapted to the tooth to obtain the best contour possible.
3. Teeth were restored by group as follows.

Table 1 –Microleakage (mean) Results

Group 1Dyract		Group 2Ketac		Group 3Amalgam		Group 4SSC		Group 5IRM	
Tooth #	Scale	Tooth #	Scale	Tooth #	Scale	Tooth #	Scale	Tooth #	Scale
1	0	1	3	1	2	1	2	1	3
2	0	2	3	2	2	2	2	2	3
3	2	3	3	3	3	3	0	3	3
4	1	4	3	4	3	4	2	4	3
5	0	5	2	5	3	5	2	5	3
6	0	6	3	6	3	6	2	6	2
7	0	7	3	7	3	7	2	7	3
8	0	8	3	8	3	8	2	8	3
9	0	9	3	9	3	9	2	9	3
10	0	10	3	10	2	10	2	10	3
11	2	11	3	11	-	11	2	11	3
12	-	12	3	12	-	12	-	12	-

Score 0: No Leakage
Score 1: Leakage from/beginning at Occlusal surface only
Score 2: Leakage from/beginning at Cervical surface only
Score 3: Leakage from Occlusal and Cervical surfaces

GROUP 1

A capsule of IRM Caps (Dentsply Caulk, Mildford, Del) was mechanically mixed according to the manufacturer's instructions. IRM was incrementally placed and packed, filling the pulp chamber to one third to one half of the remaining coronal height, but leaving the lateral walls clean. A layer of Vitrebond (3M Espe Dental Products, St. Paul, Minn) covered the IRM on the pulpal floor and was cured for 30 seconds. Dyract AP (Dentsply Caulk, Mildford, Del) filled the cavity in 2 to 3 increments, according to the manufacturer's instructions.

GROUP 2

IRM Caps was prepared, and the material was condensed the same way as previously mentioned. Ketac Molar (3M Espe Dental Products, St. Paul, Minn) was activated, mixed, and injected into the cavity according to the manufacturer's instructions, and the restoration was completed.

GROUP 3

IRM was prepared the same way as group 1, and teeth were restored with amalgam (Tytin Kerr Corporation, Romulus, Mich).

GROUP 4

IRM filled the entire cavity. The tooth was then prepared for a SSC. After complete seating and verification of good adaptation and retention, the crown (3M Espe Dental Products, St. Paul, Minn) was cemented to the tooth with GC Fuji I glass ionomer cement (GC America, Inc, Alsip, Ill). Excess cement was removed after cementation.

GROUP 5

IRM completely filled and restored the teeth. This group was used as the control.

Immediately after the restoration, teeth were returned to separate labeled containers filled with water.

After thermocycling for 500 cycles, with temperatures varying between ±5°C and ±55°C:

1. Teeth were immersed in methylene blue dye for 24 hours.
2. Teeth were attached to plaster blocks.
3. Three sections were made for microleakage evaluation—each made 0.5 mm from the edges of the restoration, with one in the center.

Leakage was evaluated according to the following criteria:

1. score 0=no leakage;
2. score 1=leakage originated at occlusal surface only;
3. score 2=leakage originated at cervical surface only;
4. score 3=leakage from occlusal and cervical margins.

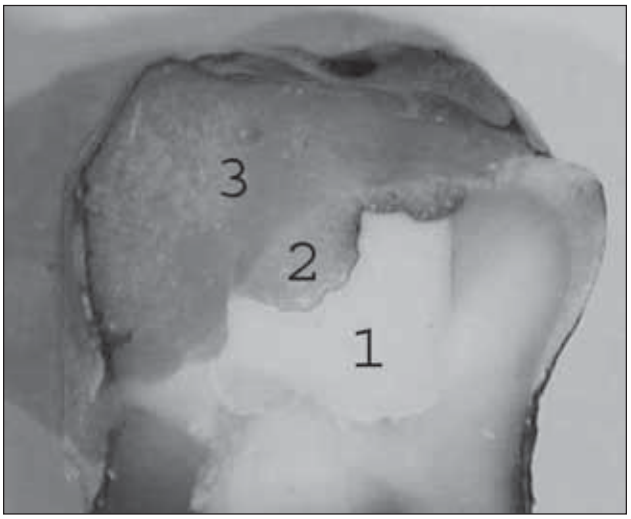

Figure 1. Pulpotomized primary molar restored with IRM (1)+Vitrebond (2) and Dyract AP (3) with no leakage.

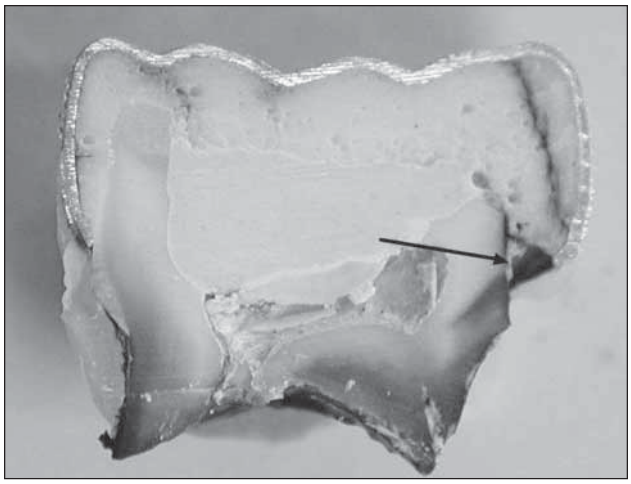

Figure 2. Pulpotomized primary molar restored with a stainless steel crown showing leakage of the uncovered proximal margin.

The highest leakage score for each tooth was logged, and results were statistically compared using Kruskall-Wallis and Mann-Whitney nonparametric tests with a significance level of $P<.05$. These tests were completed using SPSS for Windows, version 10.0.5.

RESULTS

Five restoration samples were lost during the sectioning technique and, thus, were excluded from the analysis. Leakage scores for each group of restorations are presented in Table 1. As a group, Dyract AP restorative material (Figure 1) demonstrate significantly less leakage than the other groups ($P=.000$). Leakage from occlusal and cervical margins was found for most of the specimens of groups 2, 3, and 5. SSCs, even when perfectly adapted, were not able to avoid dye penetration at the cervical margin. For this group, leakage was only recorded at the gingival margin of the proximal restoration side and not on the intact proximal surface (Figure 2).

DISCUSSION

This study's results demonstrated that an excellent marginal seal could be obtained when bonding agents and resin-based materials were used to restore primary teeth after pulpotomies. Berg and Donly[6] suggested a conservative technique for pulpotomized primary molar restorations when enough tooth structure is left after carious tissue is removed. El-Kalla and García-Godoy[7] demonstrated that bonded resin-based materials increased the fracture resistance of primary teeth restored after pulpotomies. A clinical study confirmed this in vitro finding.[5]

When amalgam was compared to SSCs for restorations of pulpotomized primary molars,[4] a higher failure rate for proximal restorations was found when compared to occlusal surfaces only. The authors concluded that primary molars can be successfully restored with one surface amalgam after pulpotomy if their natural exfoliation is expected within not more than 2 years. In this study, severe leakage was found from both occlusal and cervical margins.

Ketac Molar was used in this study to mimic Atraumatic Restorative Treatment (ART) type of restorations. The manufacturer recommends this material for primary molar restorations and for long-term temporary restorations. This study's results demonstrated very poor sealing quality.

IRM was used as the most common temporary restorative material after pulpotomies, especially when this treatment is performed on an emergency basis. Guelmann et al[8] demonstrated high failure rates when IRM is not replaced by a permanent restoration (SSC). This study's results confirm those clinical observations.

The SSC group results were somehow surprising. The crowns were very well adapted before cementation and no leakage was expected. Most of the specimens, however, demonstrated cervical leakage on the restoration side. This can be explained partly by the gingival extension of the proximal margin of the restoration closed or at the cementoenamel junction, not allowing complete coverage by the SSC margins. The glass ionomer cement was not good at helping to seal the margins hermetically. Clinical extrapolation of these results needs to be made carefully, due to the highly documented success (over 80%) of this restoration type in primary teeth. This study demonstrated that incomplete or inadequate coverage of the proximal margin, when IRM is used to fill the pulp chamber and the remaining tooth structure, may also cause failure of the pulpotomy procedure and not the fixative agent only. Further studies should evaluate this possible correlation.

Intact (noncarious) and carious primary molar teeth were utilized in this study. The rationale for that use was to avoid extraction by more accurately mimicking the natural mouth environment where deep, proximally extended cavities and standard extended lesions (enamel only) are also restored.

CONCLUSIONS

Among the materials used in this study to restore pulpotomized primary molars, only resin-based materials and bonding agents successfully seal occlusal and cervical margins of pulpotomized primary molars. The gingival extension of proximal restorations should be carefully examined for complete coverage by SSCs margins before cementation.

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