Pulpectomies in primary incisors using three delivery systems: an *in vitro* study

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This in vitro *study assessed the quality of pulpectomies in primary incisors using three filling systems: syringe with plastic needle, syringe with metal needle, and lentulo spiral. Preoperative radiographs of sixty extracted primary incisors were taken, canals were prepared and obturated. Postoperative radiographs taken in two directions were evaluated by two independent evaluators blinded to the technique used. Filling quality was determined by analyzing radiopacity, presence of voids and amount of material in the canal. After statistical analysis, this study showed that NaviTip system offered a more desirable filling quality than lentulo and Vitapex syringe techniques.*
J Clin Pediatr Dent 28(4): 323-326, 2004

INTRODUCTION

Pulpectomy of primary teeth is indicated when inflammation of the pulpal tissue involves the radicular pulp or when non-vital pulp tissue is diagnosed. The treatment consists of extirpation/debridement of the pulp tissue, filing of the canal(s) to remove organic debris and obturation with an antibacterial, resorbable filling paste. The primary goal of this procedure is to maintain arch length and function by preserving primary teeth that are essential to proper guidance of the permanent dentition.[1]

Several different products have been reported as successful filling materials for pulpectomies of primary teeth. Among the most common materials are zinc oxide and eugenol (ZOE), iodoform, calcium hydroxide, Endoflas, Kri paste, Maisto's paste, and Vitapex. Reported success rates of these materials range from 68.7%-100%.[2-7]

Various filling techniques have been reported: the pressure syringe,[8,10] pre-mixed syringe,[9] the lentulo spiral[3-7] and endo plugger.[10] An ideal filling technique should assure complete filling of the canal without overfill and with minimal or no voids. Clinical indication of a completely filled canal is the expression of the filling material out of the coronal portion of the canal during the obturation procedure. Confirmation of filling quality is obtained from a postoperative radiograph. Sometimes, material reinsertion is necessary, increasing treatment time. Dandashi *et al.* evaluated three endodontic filling techniques for primary teeth and found no statistically significant differences among them. Ideal filling results for all the specimens were not achieved with any of the techniques tested in that study.[10]

Vitapex®, an iodoform-calcium hydroxide based paste, is delivered by a disposable plastic needle connected to a syringe. Due to thickness and limited flexibility of the plastic needle, it is questionable if the tip is able to reach the apex of all canals. This leaves uncertainty in the practitioners mind as to whether the material is expressed to the end of the canal or not. Recently, a thin, very flexible metal tip was introduced to the market to deliver root canal sealers (NaviTip™, Ultradent Inc, South Jordan, UT, United States). NaviTips come in different lengths and a rubber stop may be adapted to it. EndoSeal™ (Ultradent Inc, South Jordan, UT), a syringe delivered ZOE based canal sealer can be expressed by the NaviTip system.

The purpose of this study was to compare the filling quality of two-syringe delivery systems with the traditional lentulo spiral technique for pulpectomies of extracted primary incisors.

MATERIALS AND METHODS

Seventy extracted primary anterior maxillary and mandibular teeth having at least two-thirds remaining root and no signs of advanced inflammatory root resorption were collected. After extraction, teeth were placed in ten percent formalin. The teeth were prepared by removing all tissue remnants with a sickle scaler and when caries was present, carious tissue was removed with a #4 round bur. The teeth were thoroughly cleaned with coarse pumice (Henry Schein Inc, Indianapolis, IN) and stored in distilled water.

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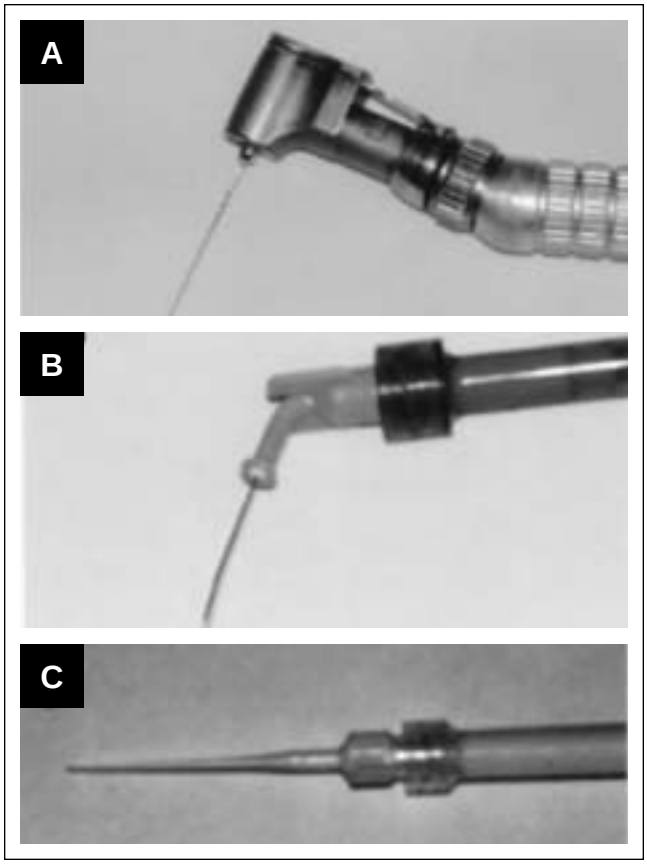

Figure 1. Delivery system methods: **A)** Lentulo spiral; **B)** NaviTip™ system; **C)** Vitapex® syringe.

When preparing samples, teeth were placed on paper towels to air dry. When completely dry, blue rope wax (Surgident®, Miles Inc, South Bend, IN) was used to cover the apex of each root. A hollow center was created into the wax to serve as a collection area for any extruded canal filling material. Each tooth was suspended vertically in a disposable dappen dish (Henry Schein Inc, Indianapolis, IN) leaving two to three millimeters between the wax and the bottom of the dish. Pink orthodontic acrylic (Dentsply-Caulk, Milford, DE) was poured into the dish submerging the roots, leaving the coronal third of the root and the crown uncovered. After 24-48 hours, specimens were placed on a flat table and preoperative radiographs were taken in a facial-lingual direction perpendicular to the long axis of the tooth keeping at a distance of ten millimeters from the cone (Philips x-ray machine Dens-O-Mat).

Access to the pulp was gained using a #330 carbide bur. Coronal pulp tissue was removed with a #4 round carbide bur. The canals were cleaned with a medium broach and hand instrumented to a size forty file. Sterile water was used to clean the canals between file sizes and at the completion of instrumentation. The canals were dried with medium paper points and obturation was performed with three delivery methods (Figure 1).

Ten teeth were used for technique calibration. The remaining sixty teeth were then divided into four groups of fifteen teeth each.

Root canals on Group 1 were obturated with a ZOE based paste, mixing zinc oxide powder (Moyco® Industries Inc, Philadelphia, PA) with eugenol until a creamy consistency was obtained. A size thirty lentulo spiral mounted to a slow speed handpiece was used as the deliver method. A rubber stop was adjusted for every tooth based on preoperative measurement, staying one to two millimeters from the radiographic apex. When backfill of the material into the pulp chamber occurred, the canal was assumed to be filled and the lentulo spiral was removed. Cotton pliers holding a wet cotton pellet were used to lightly press the material inside the canal, creating space for a temporary restoration (IRM®, Dentsply-Caulk, Milford, DE).

Group 2 was filled with Vitapex® syringe system (Diadent® Neo Dental Chemical Products Co, Tokyo, Japan). The plastic tip was placed into the canal opening and the material was injected. Once backfill into the pulp chamber occurred, the canal was assumed to be filled. Cotton pliers holding a wet cotton pellet were used to lightly press the material creating space for a temporary IRM® restoration. A rubber stop could not be fitted to the plastic tip, therefore was not used with this technique.

Group 3 was filled using the NaviTip™ and EndoSeal™(ZOE). The metal tip was placed into the canal opening, a rubber stop was adjusted to the predetermined measurement, and the material was expressed. Once backfill of filling material occurred, the canal was assumed to be filled. A temporary IRM® restoration was placed as described above.

Group 4 was filled with Vitapex® paste using a size thirty lentulo spiral. The paste was expressed onto a mixing pad and the lentulo spiral with a rubber stop was used to deliver the material as described for Group 1.

Two postoperative radiographs, one facial-lingual and one mesial-distal, of each tooth were obtained to using the same radiographic settings described for the preoperative radiographs.

Each radiograph was mounted in a slide frame and projected onto a screen. Two evaluators, blinded to the filling technique and material, assessed radiopacity, presence of voids and canal obturation quality. Quality of canal obturation was based on the amount of paste in the canal: less than one-half of the canal filled, greater than one-half but less than flush, flush (even with the apex) and overfilled. Twenty radiographs of the ten calibration teeth filled with different techniques, were used to calibrate the evaluators. When disagreement occurred, the radiograph was reevaluated and a diagnostic consensus was reached (Figures 2 and 3). Data was submitted to statistical analysis using SPSS Program for Windows.

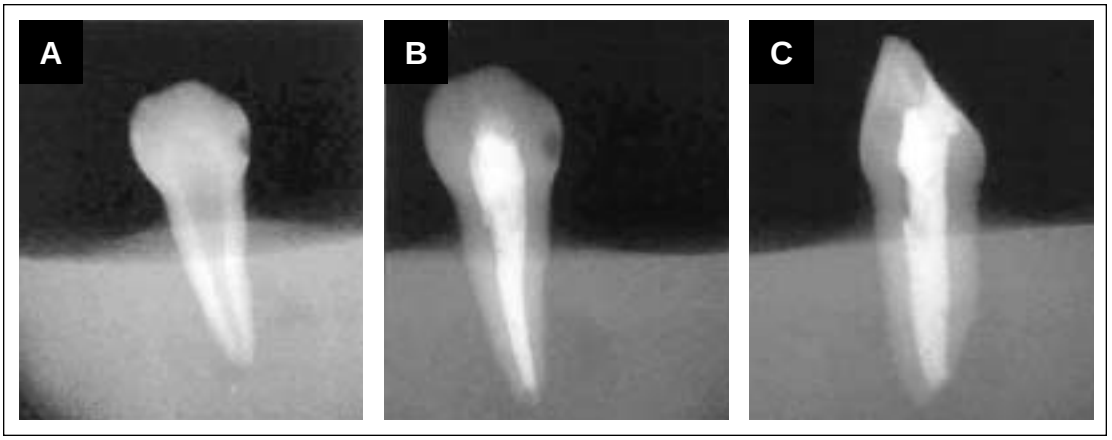

Figure 2. Flush filling with lentuloVitapex: **A)** Preoperative view; **B)** Post-op buccal-lingual view; **C)** Post-op mesiodistal view.

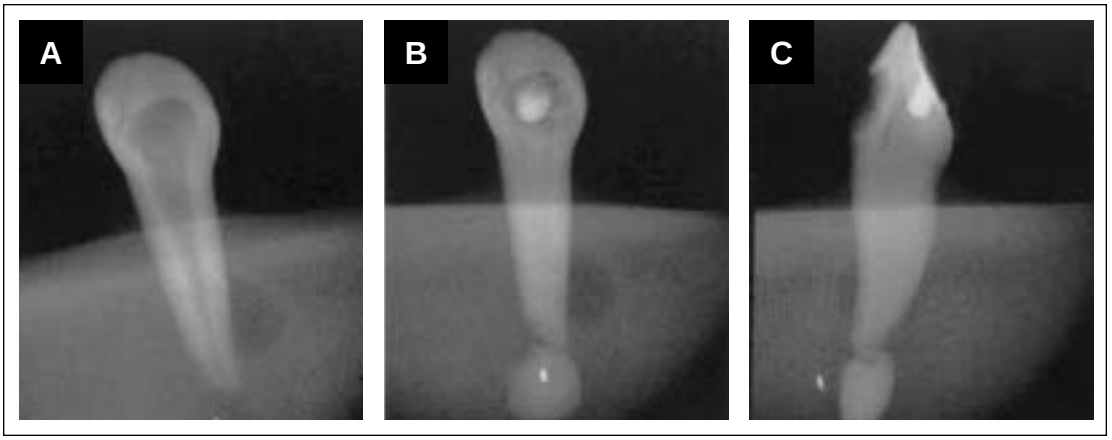

Figure 3. Overfilled filling with NaviTip™ system: **A)** Preoperative view; **B)** Post-op buccal-lingual view; **C)** Post-op mesiodistal view.

RESULTS

Chi-square test indicated EndoSeal™ delivered by NaviTip™ showed significantly less radiopacity than the other groups ($X^2_{(3)}$= 60.000, p<.05). No significant differences were noted between the radiopacity of the ZOE paste and the Vitapex® groups regardless the delivery method used (Table 1).

A pairwise comparison was performed to test for the presence or absence of voids. The results indicated EndoSeal™ delivered by the NaviTip™ had fewer voids (66.7%) compared to the lentulo spiral with both materials (93.3%) and Vitapex® syringe (100%), Table 2.

For canal obturation quality, Kruskal-Wallis test indicated that NaviTip™ was better than the other delivery methods ($X^2_{(3)}$= 21.359, p<.001). The chi-square test indicated that Vitapex® syringe was not statistically different than lentulo Vitapex® ($X^2_{(1)}$ = .234, p=.629). When NaviTip™ ZOE was compared to the lentulo ZOE, a statistical difference was found ($X^2_{(1)}$ = 18.246, p=.001). When Vitapex® syringe was compared to NaviTip™ ZOE, a statistically significant difference ($X^2_{(1)}$= 6.211, p=.013) was found. No statistically significant difference was found between NaviTip™ ZOE and lentulo Vitapex® ($X^2_{(1)}$= 3.520, p=.061). Lentulo Vitapex® results were statistically significant better than lentulo ZOE ($X^2_{(1)}$= 8.697, p=.003). Vitapex® syringe was statistically significant when compared to lentulo ZOE ($X^2_{(1)}$= 6.167, p=.013), Table 3.

DISCUSSION

Presence of voids was a constant finding in this study. This observation was perhaps due to radiographs taken in two directions. The NaviTip™ system showed the least amount of voids among the techniques. In a report by Dandashi *et al.*[10] voids were also frequently observed, with the pressure syringe resulting in the fewest voids, but reported to be the most complex and time consuming technique.

For radiopacity quality, no difference was found between Vitapex® and mixed ZOE. EndoSeal™ showed poor contrast, but a presence could be identified radiographically by disappearance of the lumen of the canal when comparison of the pre and post fill radiographs was made (Figure 3).

When reports of clinical investigations were analyzed regarding obturation quality, regardless the material used, high success rates were obtained with flush and underfilled fillings.[4-6] The success rate dropped significantly when overfilling occurred,

Table 1. Radiopacity

	POOR	GOOD	N
Lentulo ZOE	0	15	15
NaviTip ZOE	15	0	15
Lentulo Vitapex	0	15	15
Vitapex	0	15	15

Table 2. Voids

	PRESENCE	ABSENCE	N
Lentulo ZOE	14	1	15
NaviTip ZOE	10	5	15
Lentulo Vitapex	14	1	15
Vitapex	15	0	15

Table 3. Obturation quality

	<1/2	>1/2 < FLUSH	FLUSH	OVERFILLED	N
Lentulo ZOE	4	11	0	0	15
NaviTip ZOE	0	4	8	3	15
Lentulo Vitapex	0	10	2	3	15
Vitapex	1	10	3	1	15

despite the material in use.[4-6] Coll and Sadrian[11] stated that the amount of preoperative root resorption seemed to be the most important radiographic diagnostic criterion in determining whether a pulpectomy will likely succeed. Holan and Fuks[5] suggested that success differences maybe related to the pathologic condition of the tooth prior to treatment than to the filling technique per se.

Lentulo spiral is a widely accepted and successful technique for endodontic deliver of root canal sealers.[8] Good operator skills need to be developed to obtain good results. Even experienced operators sometimes need to reinsert material to assure good filling quality, consequently adding more treatment time.[5]

The pre-mixed Vitapex® delivered by a plastic tip used in our study resulted in 66% of the short fillings and 20% of the flush fillings. Despite good clinical results reported with this technique[9], tip thickness, limited flexibility, difficulty to adapt a stopper and operator experience with the delivery system may explained the less than ideal results. In order to improve the study design, an attempt to adapt the NaviTip™ needle to the Vitapex® syringe was made. Unfortunately, due to paste thickness, material could not be expressed via the NaviTip™ lumen. EndoSeal™, a ZOE based root canal sealer, was then chosen because of its capacity of being delivered by the NaviTip™ system. Based on instructions of the manufacturer, the material can be placed close to the apex of the root, eliminating or minimizing air entrapment. In case of overfilled paste, resorption should occur with no problems. No clinical investigations have reported success.

The NaviTip™ system demonstrated the highest number of flush or complete fillings. The operator (MM) also reported the technique fast and user friendly. The thin metal tip allowed the operator to feel more confident that the tip, and thus, the material were at the apex of the root.

CONCLUSION

In conclusion, this study showed the NaviTip™ system provided a more reliable filling quality than lentulo and Vitapex® syringe techniques when voids, radiopacity and degree of canal fill were evaluated.

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