

# Treatment Outcomes of Pulpectomy in Primary Maxillary Incisors Filled with ZOE and Metapex: A Two-year Retrospective Study

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**Objectives:** To address a literature gap by evaluating, in a larger set of samples, the clinical and radiographic outcomes of pulpectomy in primary maxillary incisors using ZOE and calcium hydroxide/iodoform paste. To also identify the predisposing factors for treatment outcomes. **Study design:** Medical charts of 124 patients (aged 16 to 60 months) and radiographs of their incisors (309 incisors) were reviewed (128 with ZOE and 181 with Metapex). All incisors were restored with composite resin crowns. **Results:** The radiographic success rates for ZOE and Metapex were: 85.9% and 82.9% at the 12-month recall, and 69.2% and 64% at the 24-month recall, with no statistically significant difference between the two groups. Clinical failures occurred more frequently in the Metapex group ( $P = 0.006$ ), as clinical signs of pain and soft tissue pathosis were found in 6.2% of the Metapex cases at 24 months but none in the ZOE group. Significant predisposing factors for radiographic success were type of tooth, degree of obturation at recalls, and preoperative root resorption. **Conclusions.** The radiographic success rates are comparable between the ZOE and Metapex groups. Clinical pathological manifestations such as pain and soft tissue pathosis are seen in the Metapex group at recalls, but none in the ZOE group. Predisposing factors such as type of incisor, preoperative root resorption, and extent of filling at recalls are associated with the radiographic success rate.

**Keywords:** Endodontics, Primary incisors, Pulpectomy

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## INTRODUCTION

In Taiwan, bottle feeding and breastfeeding during sleep are common and have led to severe early childhood caries in upper anterior teeth.<sup>1</sup> However, parents usually prefer maintaining the integrity of children's dental arches to tooth extraction. The loss of primary incisors may result in loss of dental space, phonetic alteration, reduced masticatory force, unpleasant aesthetics, and development of parafunctional habits. However, preserving primary incisors can be difficult, given the weaker crown and root structures in incisors than in molars. Less favorable treatment outcome has also been reported with pulp therapy in anterior teeth than in molars.<sup>2</sup>

Zinc-oxide eugenol (ZOE) was the first root canal filling material widely used for primary teeth. Despite its moderate-to-high success rate, extruded ZOE paste beyond the apices may set into a hard cement and resist resorption<sup>3,4</sup>, potentially disturb the eruption of succedaneous teeth<sup>5</sup>, and cause mild foreign body reactions.<sup>6,7</sup> Today, many pediatric dentists are opting for the calcium hydroxide/iodoform paste: Vitapex<sup>®</sup> (Neo Dental International, Federal Way, Wash., USA) or Metapex<sup>®</sup> (Meta Biomed Company Ltd., Korea). The calcium hydroxide/iodoform paste does not set into a hard mass, and has also been shown to be resorbed at a similar or faster rate than the rate of the root itself.<sup>8</sup> The main ingredients are iodoform 30-40%, calcium hydroxide 30%, and silicone oil. It is available pre-mixed in syringes and disposable tips. Extruded paste can be resorbed in 1 to 2 weeks, with no foreign body reactions.<sup>9,10</sup>

Previous studies comparing the success rates of ZOE and calcium hydroxide/iodoform paste used small sets of samples (45 to 60 primary teeth) consisting mostly of molars.<sup>11</sup> The study by Mortazavi reported an inferior treatment outcome with ZOE in molars plus 5 incisors<sup>12</sup>, while other studies found no significant difference in the success rates in molars between these two materials.<sup>13-17</sup> Only a handful of studies have investigated pulpectomy in primary incisors and reported success rates ranging from 59% to 96%, and most of these studies used ZOE as the filling material.<sup>2,18-22</sup>

Hence, the goal of this retrospective study is two-fold:

1. To assess the outcome of pulpectomy in primary maxillary incisors filled with ZOE or calcium hydroxide/iodoform paste (Metapex®), using a larger set of samples; and
2. To determine the predisposing factors for the outcome of pulpectomy.

## MATERIALS AND METHOD

Dental records were reviewed of patients aged 1 to 5 who visited the Department of Pediatric Dentistry at the Linkou Branch of the Chang Gung Memorial Hospital (Taiwan) from 2009 to 2016 to undergo pulpectomy for 1 or more primary maxillary incisors. The current study was approved by the Medical Foundation Institutional Review Board at the Chang Gung Memorial Hospital (201700307B0D001).

The inclusion criteria were as follows:

- pulpectomy treatment performed due to deep carious lesions involving pulp or showing signs of pulp necrosis (abscess, fistula, radiographic apical lesion, etc.);
- restoration with composite strip crowns;
- availability of preoperative and immediate postoperative diagnostic radiographs, as well as radiographs taken at 12-month & 24-month recalls.

Teeth with extensive root resorption (more than one-third of the intact root length) before the treatment were excluded. Radiographs which failed to meet the following criteria were also excluded: proper contrast, non-distortion and clarity of the teeth and adjacent osseous structure. Gingival swelling, sinus tract, periapical radiolucency, and external root resorption of less than one-third of the root length were not considered contraindications for pulpectomy.

All teeth were treated as follows. Local anesthesia was administered, using 2% lidocaine with 1:100,000 epinephrine. The tooth was isolated with a rubber dam. Dentinal caries was removed; access to the pulp chamber was achieved. The root canal was instrumented using Kerr files, and copious irrigation with 3% sodium hypochlorite was carried out. The canal was then dried with paper points and filled with the calcium hydroxide/iodoform paste (Metapex) using a prepackaged syringe, or a homogenous thin mix of ZOE paste (zinc oxide USP mixed with eugenol USP) using a rotary lentulo spiral. All teeth were restored with strip crowns using a celluloid crown form (Pedo Strip Crowns, 3M/Unitek, St. Paul, Minn., USA) to restore functions and to prevent microleakage. Immediate postoperative radiographs were taken to assess the adequacy of the filling. Film holders were employed to obtain reproducible periapical radiographs.

The following clinical information was also recorded: (1) type of incisor (central or lateral), (2) age of the patient at the time of treatment, and (3) any spontaneous pain or fistula/abscess before the treatment. The presence of periapical radiolucent lesions, pathological root resorption, and the condition of root formation (complete or immature) before the treatment were also recorded.

Postoperative recalls at 12 and 24 months were arranged for all patients, and a standard protocol was followed. Patients' dental history was taken and both clinical and radiographic examinations were performed during recalls. Patients and their parents were asked if any pain or gum swelling around treated incisors was experienced by the patients. The integrity of restoration and the gingival health were recorded on the patient chart. Periapical radiographs of treated teeth were also taken.

The clinical and radiographic criteria presented in the systemic reviews by Smail-Faugeron *et al* (2013) were used as guidelines to formulate the criteria for outcome evaluation in the current study.<sup>11,23</sup> Clinical success was defined as: 1) a lack of pain symptoms (history of spontaneous pain, chewing sensitivity, pain on palpation, tenderness to percussion, etc.), and 2) no soft tissue pathosis (gingival swelling, sinus tract, abscess, or purulent exudate from the gingival margin). Periapical radiographs of treated incisors at 4 time points—preoperative, immediate postoperative, and 2 recalls (12 months and 24 months)—were evaluated. Radiographic success was defined as: 1) no increase of pathologic root resorption, and 2) no newly formed or increased pathologic radiolucency. The extent of filling was also examined: “overfilled” was defined as filling materials extruding beyond the root apex; “underfilled” was defined as the extent of filling being more than 2mm short of the root apex. The eruption status of the succedaneous tooth was assessed through a comparison with the eruption time of the untreated contralateral tooth and/or the adjacent teeth.

Radiographic evaluations were performed by three investigators who were all experienced pediatric dentists. A calibration training session was held first where 40 randomly selected radiographs (not part of the current study) were rated by the three rating investigators. The inter-rater agreement was determined using the Cohen's kappa statistic. The Kappa values ranging from 0.69 to 0.92 indicated a substantial-to-almost-perfect agreement in each pair of raters when assessing the status of roots and periapical lesions. All three rating investigators were blinded to the filling material used as well as the patient and the clinician who restored the tooth. When different ratings were assigned to the same incisor, either the rating by the majority of rating investigators was chosen, or a consensus was derived through discussion among rating investigators.

Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS) 17.0 (SPSS Inc., Chicago, Ill., USA). The treatment outcome was analyzed using the Pearson's chi-square and Fisher's exact tests. Logistic regression analysis was conducted to examine the correlations between the criteria evaluated and the treatment outcome. A *P*-value less than 0.05 was deemed statistically significant.

**RESULTS**

A total of 4996 patient charts were reviewed and 124 charts (330 primary maxillary incisors treated with pulpectomy) met the inclusion criteria. The mean age of patients at treatment was 39.7 months (SD = 8.6), ranging from 16 to 60 months. At the 12-month recall, 128 incisors filled with ZOE and 181 incisors filled with Metapex were analyzed (21 exfoliated teeth and those extracted due to postoperative crown/root fractures were excluded). At the 24-month recall, 120 incisors filled with ZOE and 161 incisors filled with Metapex were analyzed (28 teeth exfoliated or were extracted between the 12-month and 24-month recalls). The distribution of teeth by type and filling material is presented in Table 1. At the baseline, both study groups were comparable in terms of type of incisor (central and lateral) and patient’s age.

Both vital primary incisors and those with pathologic signs were included in the study. Twenty-three percent (71 incisors) of the pulpectomized incisors showed radiographic periapical lesions or pathological root resorption before treatment.

**3.1 Radiographic & clinical success rates of pulpectomy**

The success rates of pulpectomy using ZOE and Metapex are summarized in Table 2. At both 12-month and 24-month recalls, the differences in the radiographic success rate between the two groups were not statistically significant. However, the clinical success rate of the ZOE group was higher than that of the Metapex group at 24 months ( $P = 0.006$ ). In the Metapex group, pain was found in 1 tooth, and parulis, in 7 teeth; both pain and abscess were seen in 2 incisors. In the ZOE group, no pain or parulis was found.

**Predisposing factors for radiographic success**

Univariate analysis based on the Chi-square statistic and Fisher’s exact test were conducted to determine the predisposing factors for radiographic success. As shown in Table 3, the radiographic success rates at 12- and 24-month recalls are not significantly associated with patient’s age, root formation (complete or incomplete), strip crown integrity, or immediate postoperative extent of filling. However, the radiographic success rates are associated with type of tooth, degree of obturation at recalls, as well as preoperative root resorption and periapical lesion.

Among the 309 teeth analyzed, 195 were central incisors and 114 were lateral incisors. The radiographic success rate of pulpectomy in lateral incisors was significantly higher than that in central incisors at both 12 months and 24 months ( $P < 0.001$ ).

**Table 2 12-month and 24-month radiographic and clinical success rates.**

Radiographic success rate			
	ZOE	Metapex	P-value
12 months	85.9% (110/128)	82.9% (150/181)	0.47
24 months	69.2% (83/120)	64.0% (103/161)	0.36
Clinical success rate			
	ZOE	Metapex	P-value
12 months	100% (128/128)	98.9% (179/181)	0.52
24 months	100% (120/120)	93.8% (151/161)	0.006**

\*\* Significant difference ( $0.001 < P < 0.01$ ), Chi-square test

Sixteen percent (49 incisors) of the pulpectomized incisors had pathological root resorption. Based on the chi-square analysis, the radiographic success rate for the incisors with preoperative root resorption was significantly lower than the rate for the incisors with no root resorption at both recalls ( $P < 0.001$ ). Preoperative periapical lesions were also found to significantly affect the radiographic outcome. When the two filling groups were examined separately, preoperative root resorption and periapical lesion were significantly related to radiographic success only in the Metapex group, although lower success rates at both 12-month and 24-month recalls were also seen (albeit not statistically significant) in the ZOE group for cases with preoperative root resorption and periapical lesion.

In terms of the extent of filling at recalls, the radiographic success rates for underfilled and overfilled cases were significantly lower than the rate for adequate-fill ( $P < 0.001$ ) at 12 months. At 24 months, the success rates for underfilled and overfilled cases dropped further—again significantly lower than the rate for adequate-fill ( $P < 0.001$ ).

Stepwise logistic regression analysis was then conducted to evaluate the odds of radiographic success at 12 months for various predisposing factors (Table 4). Although incisors with preoperative periapical lesions were associated with a lower radiographic success rate (Table 3), it was not a significant predisposing factor for the 12-month radiographic success, according to the multiple logistic regression analysis.

**Table 1 Distribution of pulpectomized primary maxillary incisors by type of incisor and filling material.**

	12 months			24 months		
	ZOE	Metapex	Total	ZOE	Metapex	Total
Central incisors	83 (42.6%)	112 (57.4%)	195 (100%)	77 (44.5%)	96 (55.5%)	173 (100%)
Lateral incisors	45 (39.5%)	69 (60.5%)	114 (100%)	43 (39.8%)	65 (60.2%)	108 (100%)
Total	128 (41.4%)	181 (58.6%)	309 (100%)	120 (42.7%)	161 (57.3%)	281 (100%)

**Table 3 Univariate analysis of predisposing factors for the radiographic success of pulpectomy.**

	12-month radiographic success rate			24-month radiographic success rate		
	ZOE	Metapex	Total	ZOE	Metapex	Total
<b>Tooth type</b>						
central incisor	79.5% (66/83)	75.9% (85/112)	77.4% (151/195)	57.1% (44/77)	47.9% (46/96)	52.0% (90/173)
lateral incisor	97.8% (44/45)**	94.2% (65/69)**	95.6% (109/114)***	90.7% (39/43)***	87.7% (57/65)***	88.9% (96/108)***
<b>Extent of filling at recalls</b>						
Underfill	83.3% (5/6)	62.2% (23/37)	65.1% (28/43)	30.3% (3/10)	52.5% (52/99)	50.5% (55/109)
Adequate	91.8% (89/97)	88.0% (125/142)	89.5% (214/239)	89.7% (70/78)	82.3% (51/62)***	86.4% (121/140)
Overfill	64.0% (16/25)**	100% (2/2)**	66.7% (18/27)***	31.2% (10/32)***		31.2% (10/32)***
<b>Preoperative root resorption</b>						
Absent	88.7% (94/106)	87.7% (135/154)	88.1% (229/260)	72.7% (72/99)	70.3% (97/138)	71.3% (169/237)
Present	72.7% (16/22)	55.6% (15/27)***	63.3% (31/49)***	52.4% (11/21)	26.1% (6/23)***	38.6% (17/44)***
<b>Preoperative periapical lesion</b>						
Absent	87.7% (93/106)	86.0% (129/150)	86.7% (222/256)	72.4% (71/98)	70.1% (94/134)	71.1% (165/232)
Present	77.3% (17/22)	67.7% (21/31)*	71.7% (38/53)**	54.5% (12/22)	33.3% (9/27)***	42.9% (21/49)***
<b>Patient age</b>						
Age <36 months	89.5% (51/57)	88.2% (67/76)	88.7% (118/133)	80.4% (45/56)*	64.7% (44/68)	71.8% (89/124)
Age ≥36 months	83.1% (59/71)	79.0% (83/105)	80.7% (142/176)	59.4% (38/64)	63.4% (59/93)	61.8% (97/157)
<b>Root formation</b>						
Complete	83.9% (73/87)	81.4% (105/129)	82.4% (178/216)	64.6% (51/79)	62.6% (72/115)	63.4% (123/194)
Incomplete	90.2% (37/41)	86.5% (45/52)	88.2% (82/93)	78.0% (32/41)	67.4% (31/46)	72.4% (63/87)
<b>Crown integrity at recalls</b>						
Intact	85.2% (75/88)	84.2% (133/158)	84.6% (208/246)	73.9% (51/69)	64.8% (79/122)	67.6% (152/225)
Fractured/ lost	87.5% (35/40)	73.9% (17/23)	82.5% (52/63)	62.7% (32/51)	61.5% (24/39)	60.7% (34/56)
<b>Extent of filling (immediate postoperative)</b>						
Underfill	85.7% (6/7)	84.6% (11/13)	85.0% (17/20)	42.9% (3/7)	46.2% (6/13)	45.0% (9/20)
Adequate	86.0% (80/93)	80.2% (93/116)	82.8% (173/209)	72.9% (62/85)	62.4% (63/101)	67.2% (125/186)
Overfill	85.7% (24/28)	88.5% (46/52)	87.5% (70/80)	64.3% (83/120)	72.3% (34/47)	69.3% (52/75)

P-value by Chi-square test and Fisher's exact test.

\* Significant difference (0.01 < P < 0.05).

\*\* Significant difference (0.001 < P < 0.01).

\*\*\* Significant difference (P < 0.001).

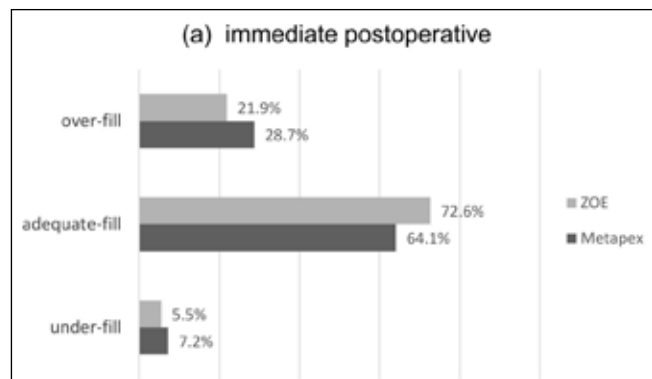
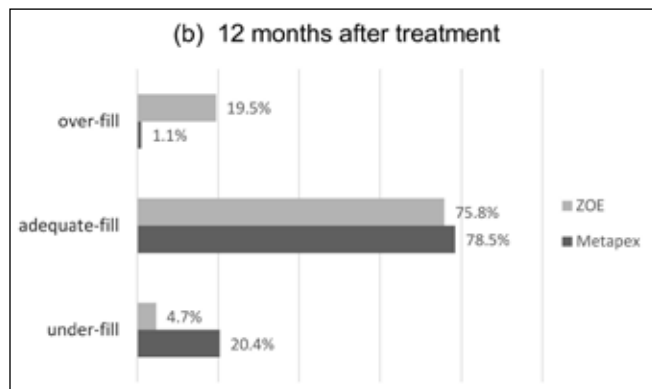
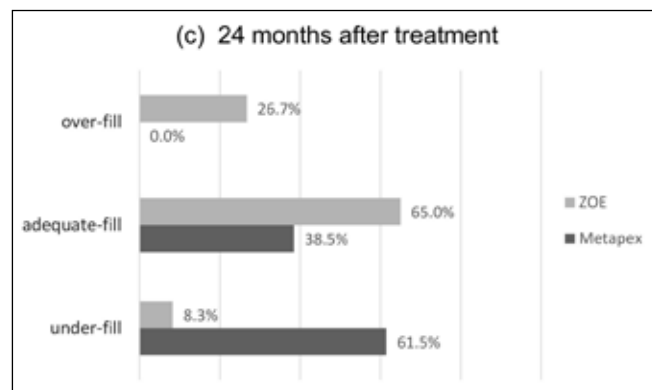
**Table 4 Multiple logistic regression analysis of the odds of radiographic success at 12 months for various predisposing factors.**

	Odds ratio	P-value
<b>Extent of filling at recalls</b>		
adequate	1	P < 0.001
underfill or overfill	0.23	
<b>Tooth type</b>		
central incisor	1	P = 0.001
lateral incisor	5.32	
<b>Preoperative root resorption</b>		
absent	1	P = 0.04
present	0.45	

**Extent of filling—ZOE vs. Metapex**

Figure 1 shows the percentage distribution of filling conditions (overfill, adequate, and underfill) using ZOE and Metapex for the primary incisor pulpectomy immediately after as well as 12 months and 24 months after the therapy. The differences in the immediate postoperative percentage distribution between the two groups were not statistically significant.

Although only 7.2% of the Metapex cases were underfilled immediately after the therapy, Metapex was lost from the canal in 20.4% and 61.5% of the cases at 12 months and 24 months, respectively. For 28.7% (52 incisors) of the cases overfilled with Metapex immediately after the therapy, the filling material extruded beyond the root apex was found in only 1.1% of the cases (2 incisors) at 12 months. In the ZOE group, the filling material extruded beyond the tooth apex was observed in 21.9% of the cases (28 incisors) immediately after the treatment. At 12 months, overfilling was found in 19.5% of the cases (only 39.3% of the extruded filling material was completely resorbed). At 24 months, fillings extruded beyond the

**Figure. 1** Filling conditions: ZOE vs. Metapex (a) immediate postoperative,**(b) 12 months after treatment,****(c) 24 months after treatment.**

root apex were actually found in more teeth (26.7%). This indicates a slower resorption rate of ZOE than the physiological or pathological root resorption.

In addition, more filling materials extruded beyond the apex were seen in incisors with preoperative pathological root resorption (33%) than those with no pathological resorption (25%), although the difference was not statistically significant ( $P = 0.24$ ). However, preoperative resorption was found to be significantly related to the loss of filling materials at recall visits. At 12 months, 37.9% of the incisors with preoperative resorption in the Metapex group were underfilled, whereas only 17.5% of the incisors without preoperative resorption were underfilled ( $P = 0.02$ ).

In terms of deflecting the eruption of permanent tooth, no deflection was seen at 24 months in 26.7% of ZOE cases (32 incisors)

where the filling material was extruded. Deflection of the eruption of permanent tooth was only found in 3 incisors—1 in the ZOE group, and 2 in the Metapex group. These 3 incisors were found to be underfilled at recalls. They also showed preoperative pathological root resorption and periapical lesions.

## DISCUSSION

The aim of the present study was to evaluate the clinical and radiographic outcomes of pulpectomy in primary maxillary incisors using ZOE or Metapex paste. The study findings indicated that while the two-year radiographic success rate was similar between the two groups, more clinical symptoms of pain and abscess were observed in the Metapex group at the two-year follow-up.

The ideal canal filling material should be resorbed at the same rate as that of the physiological root resorption. In this study, ZOE was resorbed more slowly, while the resorption of calcium hydroxide/iodoform paste was faster. Some studies have reported that the ZOE extruded beyond the apices may set into a hard cement and resist resorption.<sup>9,19,20,24</sup> A gross overfill of ZOE beyond the root apex has been found to be significantly associated with inferior treatment outcomes by Coll<sup>5</sup> and Primosch.<sup>22</sup> Conversely, Payne reported no significant relationships between the degree of obturation and the treatment outcome.<sup>2</sup> In the present study, an immediate postoperative overfill of ZOE was *not significantly* related to the radiographic outcome ( $P > 0.05$ ). However, the retention of extruded ZOE at 12 and 24 months was *significantly* associated with radiographic failures ( $P < 0.01$ ). The correlation between the extruded ZOE at 2 recalls and treatment outcome may point to the possible occurrence of periapical inflammation after the treatment. This postoperative inflammation led to pathological root resorption, which, coupled with the slower resorption rate intrinsic to ZOE, caused sustained overfilling and inferior treatment outcomes at 12-month and 24-month recalls.

Although some studies have reported deflections of the eruption of succedaneous tooth after pulpectomy, the link between such deflections and retained ZOE remains inconclusive.<sup>5,15</sup> Sadrian and Coll also found that retained ZOE particles did not induce enamel defect of permanent tooth.<sup>3</sup> In the present study, the extruded ZOE material was not completely resorbed at the 1-year recall in 17 (60.7%) of the teeth overfilled with ZOE (28 incisors). However, no deflections of the eruption of permanent tooth were found. At the 2-year recall, 5 incisors filled with ZOE had exfoliated. ZOE remnants were found to be retained in the alveolus in all these cases. The eruption of permanent tooth again appeared normal. However, the enamel appearance of newly erupted succedaneous incisors was not documented in the patient records. Post-treatment follow-up should thus continue until the primary incisors exfoliate and the status of succedaneous tooth should also be recorded.

The resorption of extruded calcium hydroxide/iodoform paste (Vitapex) has been shown to take 1-2 weeks and up to 2-3 months<sup>9,25</sup>, while other investigations have found resorption of Vitapex in the root canal within 6 to 12 months after root canal filling.<sup>13,15,26</sup> In the present study, overfill and adequate-fill accounted for 92.8% of the 181 Metapex cases (overfill: 52; adequate-fill: 116). By 12 months after the treatment, extruded Metapex was resorbed completely in 50 of the 52 overfilled cases (96.2%). Within 2 years after the treatment, filling materials were lost within the root canal among

99 of 161 Metapex cases (61.5%). Evidently, Metapex was resorbed faster than the root of primary incisors. For underfill at recall cases, a significantly higher number of radiographic failures were found in the Metapex group ( $P < 0.001$ ). This contradicts Howley's finding that intracanal resorption of Vitapex did not affect the pulpectomy outcome in the 27 primary incisors examined.<sup>21</sup>

For the clinical outcomes, 10 out of 161 (6.2%) pulpectomized incisors filled with Metapex in the present study were deemed clinical failures at 24 months. A filling covering less than half of the canal length was also found in 8 of these 10 cases. The bacteria accumulated in the canal where the filling material was lost could cause postoperative pathological changes, the so-called "hollow tube effect".<sup>27</sup> Thus, canals with an early loss of filling materials should be closely monitored and refilled, if needed, to prevent further pathological changes.

Both preoperative root resorption and periapical lesion were found to be related to inferior radiographic outcomes in the present study. As further shown by the multivariate regression analysis, preoperative root resorption affected the treatment outcome more significantly than periapical lesion. At the 2-year recall, the radiographic success rate for incisors with preoperative resorption was 38.6% and 71.3% for the cases without resorption. This echoes the findings by Coll and Sadrian that greater than 1mm of root resorption was associated with a success rate of only 23.1%,<sup>5</sup> as well as the findings from another investigation by Coll *et al*.<sup>4</sup> Interestingly, in the current study, the significant correlation between preoperative resorption and a lower radiographic success rate was only found in the Metapex group. Upon a closer investigation, the early loss of Metapex within canals occurred more often in teeth with preoperative root resorption (37.9%) than those without (17.5%) ( $P = 0.02$ ). This indicates that preoperative root resorption might have led to early washout of Metapex from canals (intracanal resorption) which in turn results in a poorer pulpectomy outcome.

In terms of the tooth type, Payne has reported a poorer pulpectomy outcome associated with anterior teeth than with molars, and suggested that bacterial leakage through cracked resin restoration could be the possible cause.<sup>2</sup> In the current study, as only incisors restored with composite strip crowns were included and teeth with non restorable fractures after treatment were excluded, bacterial leakage was not a risk factor. The radiographic success rate for pulpectomy using ZOE was 85.9% at 12 months and 69.2% at 24 months in this study, generally consistent with findings in previous studies (73% to 96% for incisors, and 65% to 86% for molars). The radiographic success rate for pulpectomy using Metapex was 82.9% at 12 months and 64% at 24 months, also consistent with rates found in earlier studies (56% to 100% for mainly molars). Therefore, the evidence emerging from the current study supports the proposition that the success rate of pulpectomy in incisors is comparable to that in molars.

As for the treatment success rates for different types of incisor, Coll<sup>19</sup> and Primosch<sup>22</sup> have found comparable success rates of pulpectomy between central and lateral incisors. However, Payne *et al* found lower success rates for central incisors than for lateral incisors and cuspids.<sup>2</sup> In the present study, the radiographic outcome for central incisors was significantly inferior to that for lateral incisors. This finding could be attributed to severe tooth decay and preoperative pathology found in the cases of this study. According to a large survey among children aged 3 to 6 in Taiwan, caries was more common among primary central incisor (56%) than among lateral incisors (24%).<sup>1</sup> Moreover, root resorption before the treatment was found in 48 central incisors (25%) and in only one lateral incisor (0.1%) in this study.

Findings of this study contribute to the debate on filling materials most suitable for primary incisor pulpectomy, while informing practitioners' plans of intervention to improve the care of patients. Instead of molars (as used in most previous studies), the present study addresses a gap in reported clinical evidence by examining the treatment outcome of pulpectomy in primary incisors and compares two filling materials—ZOE and calcium hydroxide/iodoform paste—in a larger set of samples (also unlike most earlier studies). However, the absence of recall data of some cases might have introduced biases into our analysis. In some cases, two or more incisors from the same patient were included in the analysis. A prospective and split-mouth study should be conducted in the future to validate the current findings, by applying different filling materials to incisors on different sides of the mouth.

### CONCLUSIONS

Similar radiographic outcomes are seen between the ZOE group and the group treated with calcium hydroxide/iodoform paste, although poorer clinical outcomes are found in the latter group. Predisposing factors such as type of incisor, preoperative root resorption, and extent of filling at recalls are associated with the radiographic success rate.

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