

CHAPTER 7

Clinical and Radiographic Examinations of Pulpectomy in Deciduous Teeth

Hiromichi Fujii
Tomohiro Fuchino
Yukio Machida

《Abstract》

Clinical and radiographic examinations were done on 163 deciduous teeth treated with a root canal filling material called Vitapex, which contains calcium hydroxide and iodoform. Anesthesia was administered, followed by pulp extirpation and immediate root canal filling, with observation for 5 to 1307 days. The following results were obtained.

1. Excessive bleeding during pulp extirpation seemed to adversely affect the overall clinical and radiographic results. The poor clinical condition of the pulp resulted in a higher incidence of poor results based on radiographs.
2. Deciduous teeth are susceptible to overfilling after a certain period due to root resorption. A higher incidence of good pathological scores was obtained when the root canal filling was flush, not overfilled. Radiographs confirmed resorption of excess root canal filling material in all cases.
3. During the observation period, root canal filling materials were in a stable condition and only few roots exhibited resorption. Root resorption occurred earlier or at the same time as the resorption of root canal filling material.
4. During the observation period, eruption of the succeeding permanent teeth was observed in 18 cases. In 12 out of 18 cases, eruption of the succeeding tooth did not occur at the same time as on the contralateral side (control). In 6 out of 12 cases, eruption of the succeeding permanent tooth was earlier than on the contralateral side but in 4 out of 12 cases, a delay in the replacement was observed. Also, 2 cases were replaced almost immediately.
5. During the observation period, pathological root resorption was observed in cases where root canal filling material was rapidly

- resorbed.
6. Until the last observation day, 127 out of 163 cases (77.9%) showed no clinical discomfort or adverse radiographic findings and only 36 out of 163 cases (22.1%) showed some discomfort.
 7. Signs and symptoms observed in the study were the following: 5 cases of spontaneous pain, 3 cases of pain during mastication, 10 cases of pain on percussion, 3 cases of gingival swelling, 1 case of redness, 1 case of tenderness, 3 cases of fistula and 3 cases of drainage. Discomfort was felt from the 1st to 3rd day after treatment and was mostly of a mild degree.
 8. Radiographic findings of those with clinical discomfort were the following: 2 cases with loss of lamina dura, 12 cases with incomplete resorption, 8 cases with root resorption and 5 cases with pathological lesion.
 9. In 36 cases with clinical discomfort and adverse radiographic findings, 12 cases (33.3%) had clinical discomfort only, 17 cases (47.2%) had clinical discomfort associated with adverse radiographic findings and 7 cases (19.5%) were asymptomatic but with adverse radiographic findings. Adverse radiographic findings were observed in 13 out of 91 cases (14.3%) in anterior and 23 out of 72 cases (31.9%) in posterior teeth. The clinical diagnosis of cases with adverse radiographic findings was observed in the most infectious pulpitis particularly acute suppurative pulpitis and chronic hyperplastic pulpitis.
 10. The overall clinical and radiographic results obtained in the study were the following: out of 163 cases, 127 obtained good results (77.9%) and 25 cases were fair (15.3%) for a total of 93.2% had satisfactory results. Only 11 cases had poor results (6.8%). In 151 cases with stable periodontal tissue condition from the radiograph, 117 cases obtained good results (77.5%), 23 cases were fair (15.2%) and 11 cases were poor (7.3%). Resorption of about 1/4 to 2/3 of the root occurred in 12 cases, in which 10 cases obtained good results (83.3%), 2 cases were fair (16.7%) and none of the cases was classified as poor. Root canal filling immediately after anesthesia and pulp extirpation in cases with advanced root resorption was thought to be significant.
 11. There was no change in the condition of the root in 92 cases until the last observation day. In 92 cases, 72 cases obtained good results (78.3%), 9 cases were fair (9.8%) and 11 cases were poor (11.9%). The remainder of the 59 cases with root resorption became stable within the observation period. In 59 cases, 45 cases obtained good results (76.3%), 14 cases were fair (23.7%) and no case was classified as poor.

Vitapex employed in root canal filling of deciduous teeth mostly did not induce clinical signs and symptoms, and adverse radiographic findings as well as affecting physiological root resorption confirming that this is an excellent root canal filling material.

Introduction

During the treatment of infected pulp in deciduous tooth, it is best to consider physiological root resorption and vitality of the remaining pulp. Pulpotomy has been recommended to be the most preferred treatment of vital dental pulp in many deciduous teeth in which the root pulp can still be saved [1-8]. However, in clinical practice, infection of the root pulp is usually present and so pulpectomy is often applied.

Currently, many aspects of researches on pulpectomy in deciduous teeth are still inadequate. Studies on root canal treatment of deciduous teeth and subsequent studies on root canal filling have been published, but reports on pulpectomy are infrequent [9-22].

The authors conducted a clinical and radiographic study on deciduous teeth treated with a resorbable root canal filling material Vitapex, containing calcium hydroxide and iodoform, after anesthesia and pulp extirpation. We first reported the efficacy of Vitapex as a root canal filling material in deciduous teeth [23]. Several studies of this material as root canal filling in deciduous teeth have been published [24-33]. The application of Vitapex has even been introduced in western textbooks in pediatric dentistry [2, 7]. Clinical and radiographic findings of this material used as experimental pathological root canal filling in permanent teeth have been reported [34, 35]. Further, Vitapex has been tested in immature permanent teeth with incompletely formed roots and pathological lesions [36, 37]. Tissue reactions to Vitapex have also been investigated [38-41].

Only occasional studies have focused on physiological root resorption of deciduous teeth. Therefore, cases from previous reports are still under observation. The authors considered conducting clinical and radiographic studies and add further cases of human deciduous teeth treated with Vitapex as a root canal filling after anesthesia and pulp extirpation. The observation focused specifically on the changes in the resorption of root canal filling material and roots of deciduous teeth.

Examination methods

1 Subjects

Deciduous teeth from 58 patients who visited Tokyo Dental College Hospital, Department of Pediatric Dentistry were used in the study. The patients' ages ranged from 3 years and 3 months to 8 years and 8 months. From those patients, 163 deciduous teeth were indicated for root canal therapy with pulp extirpation. Table 1 shows there were 91 anterior teeth and 72 molars. Clinical diagnoses were chronic ulcerative pulpitis, chronic hyperplastic pulpitis, acute purulent pulpitis, pulp necrosis from trauma and acute simple pulpitis. In order to avoid spreading of infection into the dentinal walls, anesthesia, pulp extirpation and root canal obturation were done immediately after diagnosis.

Table 1 Examined numbers of tooth types

Location \ Tooth types	Central deciduous incisors	Lateral deciduous incisors	Deciduous canines	First deciduous molars	Second deciduous molars	Total
Maxilla	20	30	27	14	9	100
Mandible	1	2	11	21	28	63
Total		91		72		163

Table 2 Examined number and periods

Periods	5-29 days	30- 179 days	180- 359 days	360- 539 days	540- 719 days	720- 899 days	900- 1079 days	1080- 1259 days	1260- 1307 days	Total
Examined number	7	14	15	14	28	49	22	8	6	163

2 Methodology

Anesthesia, pulp extirpation and immediate root canal filling were done as follows.

The tooth was anesthetized with 1-3 ml of 2% Xylocaine followed by moisture-proof rubber dam assembly. Prescribed disinfection of the tooth, caries removal with access opening, removal and expansion of pulp chamber and removal of the coronal pulp were carried out. Meanwhile, the cavity was irrigated repeatedly with 0.02% acrinol cleaning solution. To confirm the site of root resorption or position of the apical foramen, root canal length was measured while extirpating the pulp with barbed broach. After pulp extirpation, the canal was irrigated with 2% hydrogen peroxide and 10% sodium hypochlorite aqueous solution and dried. Vitapex was applied without excessive enlargement of the root canal.

After root canal therapy, teeth were restored. Regular recalls were done as much as possible. Table 2 shows that the minimum observation period was 5 days and the maximum was 1307 days (3 years and 7 months).

Results

Patients were observed and the presence of symptoms was compared among cases. The degree of discomfort was classified into 3 groups: mild (+), moderate (++) and severe (+++). Results of clinical and radiographic findings in general were determined by the criteria below.

Good – no discomfort after treatment throughout the observation period, lamina dura was clearly seen with normal bone without internal resorption. In case of overfilling, there was resorption of the excess filling material without alteration in physiological root resorption.

Fair – with mild to moderate discomfort which lasted for 3 days or less. Radiographs showed little resorption with slight expansion of the periodontal ligament space. Radiographic changes were not progressive and subsequently appeared to be almost not inhibiting the normal physiological processes with a little delay in resorption of drug and root canal filling material.

Poor – discomfort after treatment was remarkable with moderate pain lasting for more than 4 days and mild pain was persistent for more than a week. Soft tissue swelling was caused by unpleasant symptoms, with formation of fistula, drainage, expansion of the periodontal ligament space, progressive destruction of alveolar bone, external and internal root resorption. Resorption of root canal filling material did not coincide with physiological root resorption.

After clinical and radiographic examination, 127 cases were classified as good (77.9%), 25 cases were fair (15.3%) and 11 cases were poor (6.8%). Clinical discomforts were spontaneous pain, pain on mastication, gingival swelling, pain on percussion, redness, tenderness, fistula formation and drainage. Radiographic findings were loss of lamina dura, root resorption and pathological lesions.

Below are the clinical and radiographic findings of typical cases in this study.

Figure 1 shows case 149 (mandibular left E, male, 4 years and 6 months old, 1072 observation days) with a clinical diagnosis of chronic ulcerative pulpitis. This case did not show any sign of discomfort throughout the observation period, and a score of good was given. There

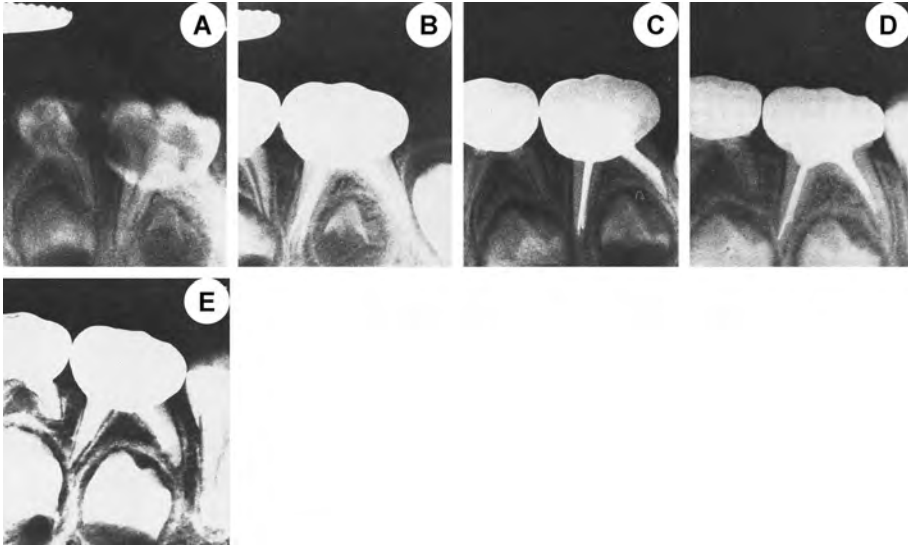


Figure 1 A: Pretreatment; B: Immeolctaly after treatment; C: Day 245; D: Day 545; E: Day 1072

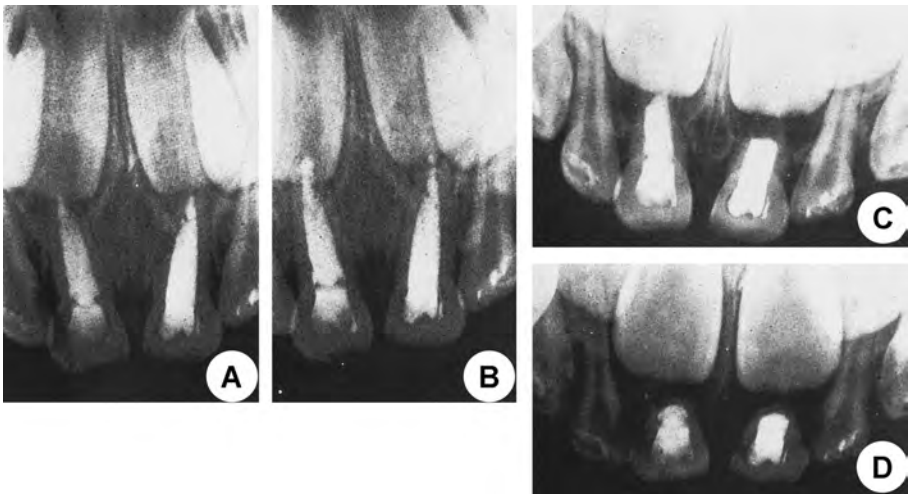


Figure 2 A: Immediately after treatment; B: Day 226; C: Day 631; D: Day 786

is no unusual finding of a lack of root canal filling. Subsequent calcification of the permanent tooth bud was in a uniform progress. Radiographic images showed good first molar eruption and relatively stability even 545 days after treatment.

Figure 2 shows cases 90 and 91 (maxillary right and left A, male, 4 years and 1 month, 786 observation days) with a clinical diagnosis of traumatic pulp necrosis. This case did not show any sign of discomfort throughout the observation period and a score of good was given. Figure 2-C shows that the resorption of maxillary left central incisor was slightly faster than the maxillary right central incisor. Resorption of the root canal filling in both canals was ahead of root resorption. Figure 2-D is 786 days after treatment showing nearly the same root resorption rate for both teeth.

Figure 3 shows case 144 (mandibular right C, male, 5 years and 8 months, 1045 observation

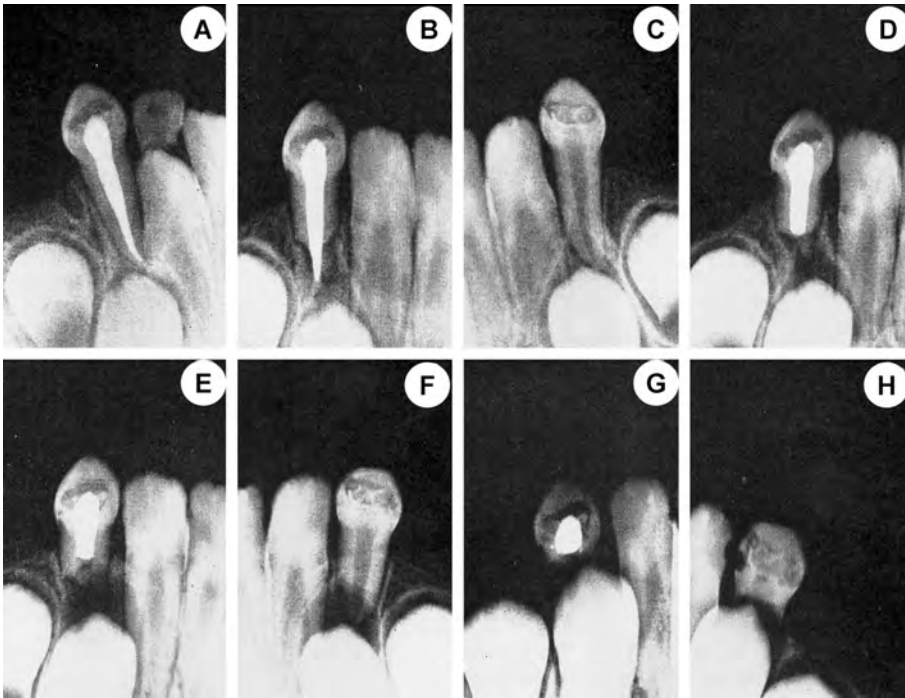


Figure 3 A: Immediately after treatment; B: Day 262; C: Day 262, control; D: Day 386; E: Day 509; F: Day 509, control; G: Day 901; H: Day 901, control

days) with a diagnosis of chronic ulcerative pulpitis. This case did not show any sign of discomfort throughout the observation period, and a score of good was given. Figure 3-C is the control, which was taken on the same day with Figure 3-B. Root resorption of the treated side is approximately 1/3 and was slightly ahead of the control side. Root canal filling material still remained at the root tip. Figure 3-D is 386 days after treatment, where resorption of the root as well as that of the root canal filling material is almost the same. Figure 3-E is 509 days after treatment, where resorption of about 1/2 of the root occurred and the filler preceded the resorption of the root. Figure 3-F is the contralateral side of Figure 3-E, taken on the same day. Root resorption of the treated side was faster. Figure 3-G is 901 days after treatment; progressing root resorption seemed favorable. Figure 3-H is the contralateral side taken on the same day. On this observation day, root resorption was the same. Figures 2 and 3 show stable periodontal ligament, which was a typical case with advanced physiological root resorption until the last observation day.

Figure 4 shows case 48 (maxillary right A, male, 6 years and 4 months, 493 observation days) with a diagnosis of chronic ulcerative pulpitis. The present case did not show any sign of discomfort throughout the observation period and a score of good was given. Figure 4-A was taken immediately after treatment where the root canal filling material was in proportion to the root. It is believed that the treatment did not cause resorption of the root canal dentin wall. Figure 4-C is 294 days after treatment where resorption of the root and root canal filling was at the same phase to the control. Figure 4-D is 453 days after treatment showing that the root was almost completely resorbed. The maxillary left central incisor has already fallen off, followed by the eruption of the permanent maxillary left central incisor. This case of root resorption during treatment is a typical example of advanced physiological root resorption until the last

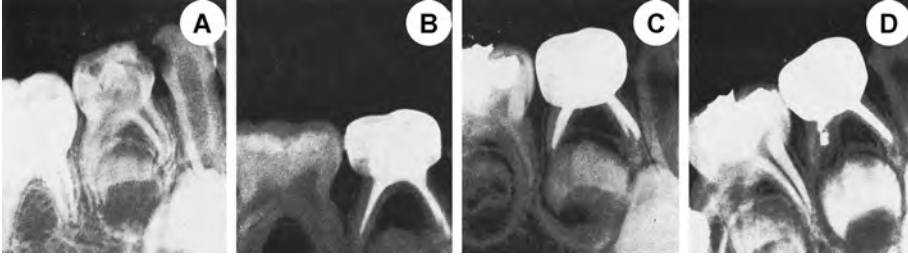


Figure 4 A: Immediately after treatment; B: Day 153; C: Day 294; D: Day 453

observation day.

The following are other typical examples and their clinical and radiographic scores.

Figure 5 shows case 133 (mandibular right D, male, 3 years and 7 months, 924 observation days) with a diagnosis of chronic ulcerative pulpitis. This case did not show any sign of discomfort throughout the observation period but exhibited pathologic resorption on the radiograph, so a fair rating was given. Figure 95-C is 460 days after treatment showing stable condition with subsequent calcification of the permanent tooth bud. Figure 5-D is 671 days after treatment showing about 2/3 resorption of the root canal filling material at the bifurcation.

Figure 6 shows case 61 (mandibular left E, male, 3 years and 7 months, 649 observation days) with a diagnosis of chronic ulcerative pulpitis. The case did not show any discomfort throughout the observation period, but a linear pathological lesion was observed at the bifurcation and so a score of poor was given. Figure 6-C is 328 days after treatment, showing uniform calcification of the permanent tooth buds. However, the root canal filling material in the mesial root canal is almost completely resorbed, reaching the bifurcation area. Figure 6-D is 406

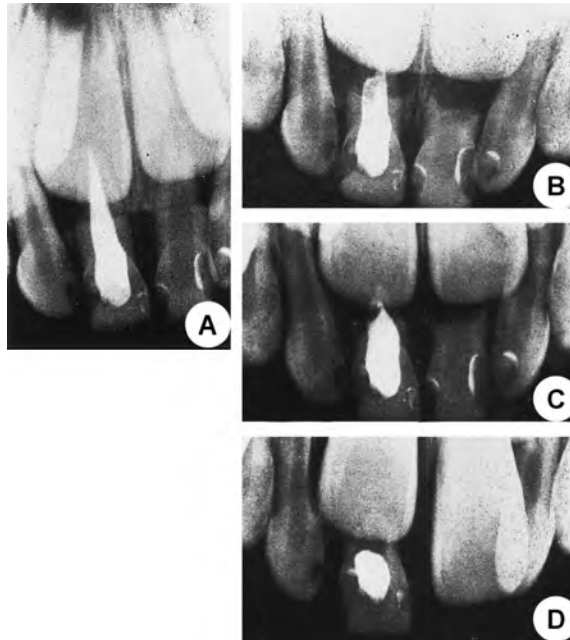


Figure 5 A: Pretreatment; B: Immediately after treatment; C: Day 460; D: Day 671

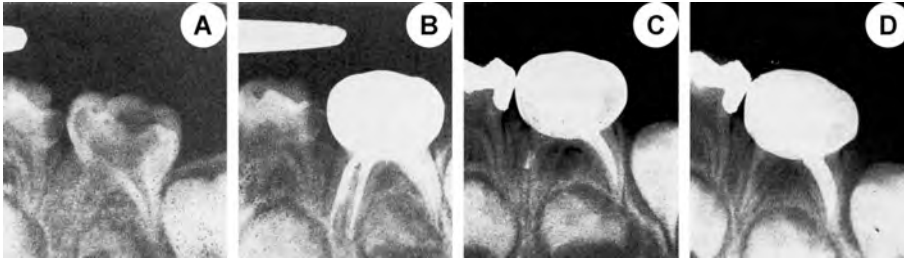


Figure 6 A: Pretreatment; B: Immediately after treatment; C: Day 328; D: Day 406

days after treatment, the mesial root canal filling material is completely resorbed and the radiolucent lesion at the bifurcation is very clear.

Discussion

1) Clinical and radiographic findings

(1) Findings during pulp extirpation

A. Hemorrhage

Hemorrhage during pulp extirpation is most probably caused by residual blood pathogens. Success of root canal treatment depends on the ability to control hemorrhage by irrigating the canal and keeping it as dry as possible prior to the application of root canal filling material. That point was confirmed in this study. In this study, root canals with marked hemorrhage were irrigated, and root canal length was measured without complete hemostasis.

Table 3 shows the relationship between hemorrhage and overall clinical and radiographic results. Marked hemorrhage seems to have a negative impact on the overall results. Moderate (++) and severe (+++) hemorrhages were remarkable. Thus, when hemorrhage is encountered during pulp extirpation, it is desirable to perform root canal treatment after hemostasis has been completely achieved.

Table 3 Relation between degree of hemorrhage and clinical and radiographic results

Degree of hemorrhage	Number examined	Results		
		Good	Fair	Poor
-	68	57 (83.8%)	9 (13.2%)	2 (3.0%)
+	81	64 (79.0%)	11 (13.6%)	6 (7.4%)
++	7	3 (42.8%)	3 (42.8%)	1 (14.4%)
+++	7	3 (42.8%)	2 (28.6%)	2 (28.6%)
Total	163	127 (77.9%)	25 (15.3%)	11 (6.8%)

B. Condition during pulp extirpation

Root canal anatomy and degree of broach insertion during pulp extirpation can be determined from pre-operative radiographs. Clinical records and radiographs should be obtained

in order to determine if the deciduous tooth is indicated for root canal treatment. Clinical examination, pre-operative radiographs, clinical condition of the tooth, degree of broach insertion, anatomy of the root canal, and condition during pulp extirpation are factors affecting the condition of the tooth after root canal treatment.

Table 4 shows the relationship between the condition during pulp extirpation and overall clinical and radiographic results. A good result was obtained when pulp extirpation was highly indicated, while poor was obtained when the pulp extirpation was least indicated.

Table 4 Relation of the conditions of pulp extirpation, clinical and radiographic results

Conditions of Pulp Extirpation	Number examined	Result		
		Good	Fair	Poor
Good	89	76 (85.4%)	11 (12.4%)	2 (2.2%)
Fair	39	32 (82.1%)	5 (12.8%)	2 (5.1%)
Poor	35	19 (54.3%)	9 (25.7%)	7 (20.2%)
Total	163	127 (77.9%)	25 (15.3%)	11 (6.8%)

(2) Findings after pulp extirpation

A. Condition of the root canal filling

Clinical signs and symptoms as well as the condition of the root canal filling on radiographic findings after root canal filling were investigated.

a) Condition of the root canal filling immediately after treatment

Overfilling in deciduous maxillary lateral incisors was observed in 13 out of 30 cases. In 16 cases with root resorption during treatment (12 teeth), 8 root canals (7 teeth) were overfilled. Thus, deciduous teeth exhibiting resorption during treatment were found to be susceptible to overfilling.

Underfilling was observed in 10 of 20 cases in deciduous maxillary central incisors, 5 of 14 cases in the buccal root of deciduous maxillary first molar, 13 of 21 cases in deciduous mandibular first molar and 16 of 28 cases in deciduous mandibular second molar.

b) Relationship between condition of root canal filling and results of clinical and radiographic findings in general

Table 5 shows the results of the condition of the root canal filling. When the root canal filling was flush, most cases obtained good results and less favorable results were obtained when the canal was over or underfilled. Combining the results of overfilled and underfilled cases showed similar results.

B. Radiographic conditions of the root and root canal filling material during the observation period

a) Excess root canal filling material on overfilling

Overfilling of the root canal was observed in 42 out of 258 root canals (16.3%). Although the

Table 5 Relation between root canal filling conditions, clinical and radiographic results

Filling conditions	X-ray result		Good	Fair	Poor
	Number examined				
Over	30		22 (73.3%)	7 (23.3%)	1 (3.4%)
Flush	60		53 (88.3%)	3 (5.0%)	4 (6.7%)
Under	63		44 (69.8%)	14 (22.2%)	5 (8.0%)
Over & under	10		8 (80.0%)	1 (10.0%)	1 (10.0%)
Total	163		127 (77.9%)	25 (15.3%)	11 (6.8%)

majority of the excess was just a small amount, it took about 1 to 3 months before the excess filling material was resorbed.

b) Condition of the root canal filling material in cases of stable phase during the observation period

Table 6 shows that 76 out of 163 cases had no pathological resorption in cases of a stable phase during the observation period. Among them, 7 had slight resorption of the root canal filling (9.2%), 10 had complete resorption of the root canal filling (13.2%) and 59 had no change in the root canal filling (77.6%). Therefore, resorption of the root canal filling material seems to be in a stable phase with very slight change.

Table 6 Root conditions and radiographic appearance of the root canal filling material

Root conditions		Number examined	Radiographic appearance of the root canal filling material		
Stable period	No root resorption		76	No change	59
		Slight resorption		7	
		Complete resorption		10	
	Pathological root resorption	8	No change	1	
			Slight resorption	3	
			Complete resorption	4	
Resorbing period	Physiological root resorption	Under 1/4	27	No change	8
			44	Almost no change	14
				Complete resorption	5
	Pathologic root resorption	Over 1/3	44	Same as root resorption	22
				Ahead of root resorption	22
Pathologic root resorption		0			

c) Condition of the root canal filling material in cases of physiological root resorption during the observation period

Table 6 shows that physiological root resorption was observed in 71 out of 163 cases. Changes in root canal filling material were observed in 63 cases. Thus a remarkable change in the root canal filling material is seen during the progress of root resorption. In 44 cases, approximately 1/3 of the root underwent physiological root resorption. As shown in Figure 2, resorption of the root and root canal filling material occurred at the same time in 22 cases (50.0%), and in another 22 cases the root canal filling material resorbed faster than the root (50.0%).

There are some cases where resorption of root canal filling material is slower than resorption of the root, as shown in Figure 3. It seemed that the root canal wall remained clear when there was a delay in the resorption of root canal filling material.

Thus, the resorption of the root canal filling material and physiological root resorption almost occurred at the same time, or resorption of the root canal filling material was ahead of physiological root resorption. However, there was a case where resorption of the root canal filling was significantly faster. A total of 18 cases were exfoliated during the observation period. In 12 cases, examination of the opposite side without root canal treatment was done. As a result, 6 cases were exfoliated earlier compared to the control, and 4 cases were delayed. Also, 2 cases were exfoliated immediately.

d) Condition of the root canal filling material in cases of pathological root resorption

Pathological root resorption was observed in 8 out of 163 cases as shown in Table 6. Among them, 3 had slight resorption (37.5%) and 4 had complete resorption of the root canal filling material (50.0%). Only 1 had no resorption (12.5%). Thus, the majority of the cases with pathological root resorption have resorption of the root canal filling material and of the root itself. This change is believed to have occurred due to the pathological resorption of the root canal.

C. Cases displaying clinical discomfort on clinical and radiographic findings

In 127 out of 163 cases (77.9%), no symptom was observed during the clinical course in this study. In 36 cases (22.1%), there was no discomfort on clinical and radiographic findings.

a) Clinical symptoms

(a) Spontaneous pain

A total of 5 out of 163 cases experienced spontaneous pain, which lasted for 3 days. In general, the pain was mild to moderate. Only 1 case was severe, and the pain lasted for 306 days after treatment. It was accompanied by gingival redness, swelling and tenderness, so extraction of the tooth was performed. In the single case with moderate pain, the tooth became asymptomatic on or after the second day. In the 3 cases with mild pain, the pain lasted for 3 days.

(b) Pain on mastication

A total of 3 out of 163 cases experienced mild pain on mastication, which lasted for 3 days. In 1 case, pain was experienced for 3 days after 575 days. After 585 days, fistula and root canal drainage appeared which led to the initiation of treatment. Two cases were asymptomatic 1 or 2 days after treatment.

(c) Pain on percussion

Pain on percussion was experienced in 10 out of 163 cases. In 8 cases, pain was observed

during the day, which lasted for 7 days. Mild pain was reported in 9 cases. However, 1 case experienced pain after 306 days; it was complicated with intense, spontaneous pain and pain on percussion. This is the same case, described above, which was extracted. Drainage was accompanied by gingival swelling after 614 days and so extraction was done. Eight cases were asymptomatic after 3 to 7 days.

(d) Soft tissue discomfort

Six cases experienced soft tissue discomfort: there were 3 cases of gingival swelling, 1 case with redness and the others with tenderness. In 3 cases, fistula or drainage or a combination of both was observed. In cases with gingival swelling, swelling and intensity appeared on the 7th day and so extraction of the tooth was done. The case with slight gingival swelling, redness, tenderness with intense spontaneous pain and pain on percussion after 306 days, as previously described, was underwent extraction. In the case with fistula and drainage after 516 days and 585 days, respectively, root canal treatment was done. In the case with gingival swelling after 614 days, extraction was performed. For cases showing the presence of a lesion on radiographs after 733 days, the tooth was extracted. Many cases with soft tissue discomfort were due to failed root canal treatment, and they were found to be impossible to save.

b) Symptomatic radiographic findings

The 24 out of 163 cases that showed radiographic findings of discomfort are shown in Table 7. The radiographic findings were 2 cases of loss of lamina dura, 12 cases of failed root resorption, 8 cases of pathological root resorption and 5 cases of pathological lesion. However, radiographic findings of discomfort appeared or disappeared during the observation period. For example, one case showed delayed resorption of the root in the radiograph 230 days after treatment, but the case did not show any particular problem after the observation period.

Table 7 Radiographic findings of discomfort

Radiographic findings of discomfort	Number of cases
Loss of lamina dura	2
Failed root resorption	12
Pathological root resorption	8
Pathological lesion	5

c) Clinical discomfort and type of tooth

Table 8 shows the relationship between clinical discomfort and type of tooth. A total of 36 cases had clinical discomfort: 13 out of 91 cases were anterior teeth (14.3%), and 23 out of 72 cases were posterior teeth (31.9%). Therefore, deciduous molars can be said to have a higher incidence of clinical discomfort than do anterior teeth. This is largely because the molars are more difficult to treat due to a more complex root canal morphology than that of anterior teeth.

d) Relationship between clinical diagnosis and clinical discomfort and radiographic findings

A total of 36 out of 163 cases showed clinical discomfort and radiographic findings during observation. These findings were observed in the most infectious pulpitis, showing a high incidence in cases diagnosed with chronic hyperplastic pulpitis and acute purulent pulpitis. This is possible because of the residual inflammatory pathogens left in the root canal or root apex

Table 8 Clinical discomfort and type of tooth

Tooth type	Number of cases	Number with clinical discomfort
Deciduous anterior teeth	91	13 (14.3%)
Deciduous posterior teeth	72	23 (31.9%)
Total	163	36 (22.1%)

after pulp extirpation. Appropriate medication for root canal treatment should be considered during the next visit.

2) Results of clinical and radiographic findings in general

Overall clinical and radiographic findings of the study are shown in Table 9. Thus immediate root canal filling technique for deciduous teeth after pulp extirpation used in the study seems to be applicable based on the high incidence of good clinical and radiographic results.

Table 10 shows that out of 163 cases, 151 cases showed stable phase and 12 cases showed root resorption when the treatment was done. Therefore, the clinical condition of the root observed in the radiograph does not seem to have much impact on healing. Extent of resorption observed in cases during treatment was approximately 1/4 to 2/3; in cases showing advanced root resorption, root canal filling immediately after anesthesia and pulp extirpation appears to be possible.

In 92 out of 163 cases, no change in a stable condition of the root until the last observation

Table 9 Clinical and radiographic results

Number of cases	X-ray examination results	Good	Fair	Poor
	163		127 (77.9%)	25 (15.3%)

Table 10 Root conditions, clinical and radiographic results

Root condition	Cases treated at root resorption period	Cases treated at root stable period	Cases treated at root stable period	
			Progress within stable period	Change to resorption period
Number examined	12	151	92	59
Results				
Good	10 (83.3%)	117 (77.5%)	72 (78.3%)	45 (76.3%)
Fair	2 (16.7%)	23 (15.2%)	9 (9.8%)	14 (23.7%)
Poor	0	11 (7.3%)	11 (11.9%)	0

day was noted. And in 59 out of 163 cases treated in a stable phase, physiologic root resorption was shown during the observation period. A summary of the results revealed that 14 cases progressed to a stable condition and better resorption of the root and were given fair results. Out of those cases, only 3 cases were symptomatic and the remaining 10 out of 11 cases showed symptomatic radiographic findings with fair results. Those cases may also be considered to have good results over time.

Conclusions

Root canal filling with Vitapex immediately done after anesthesia and pulp extirpation on deciduous teeth elicited almost no clinical symptom or discomfort without adversely affecting physiological resorption of the root and was confirmed to be an excellent method of treatment.

References

- [1] Ranly DM and Garcia-Godoy F (2000) Current and potential pulp therapies for primary and young permanent teeth. *J Dent* 28: 153-161.
- [2] Fuks AB (2005) Pulp therapy for the primary Dentition. Pinkham JR, Casamassimo PS, McTigue DJ, Fields HW and Nowak AJ ed, *Pediatric Dentistry Infancy Through Adolescence*. 4th ed, Saunders, St Louis, 375-393.
- [3] Rodd HD, Waterhouse PJ, Fuks AB, Fayle SA and Moffat MA (2006) Pulp therapy for primary molars. UK National Clinical Guidelines on Paediatric Dentistry. *Int J Paediatr Dent* 16: 15-23.
- [4] Milledge JT (2008) Endodontic therapy for a primary teeth. Ingle JI, Bakland LK and Baumgartner JC ed, *Ingle's Endodontics* 6. BC Decker Inc, Hamilton, 1400-1430.
- [5] Dunston B and Coll JA (2008) A survey of primary tooth pulp therapy as taught in US dental schools and practiced by diplomates of the American Board of Pediatric Dentistry. *Pediatr Dent* 30: 42-48.
- [6] American Academy of Pediatric Dentistry (2009) Guideline on pulp therapy for primary and immature permanent teeth. *Am Acad Pediatr Dent Ref Manu* 31: 179-186.
- [7] McDonald RE, Avery DR and Dean JA (2011) Treatment of Deep Caries, Vital Pulp Exposure, and Pulpless Teeth, Dean JA, Avery DR and McDonald RE. Ed. *McDonald and Avery's Dentistry for the Child and Adolescent*. 9th ed. Mosby, Maryland Heights, 343-365.
- [8] Waterhouse PJ, Withworth JM, Camp JH and Fuks AB (2011) Pediatric endodontics. endodontic treatment for the primary and young permanent dentition. Hargreaves KM and Cohen S ed, *Cohen's Pathways of the Pulp*. 10th ed, Mosby, St Louis, 808-857.
- [9] O'Riordan MW and Coll J (1979) Pulpectomy procedure for deciduous teeth with severe pulpal necrosis. *J Am Dent Assoc* 99: 480-482.
- [10] Coll JA, Josell S and Casper JS (1985) Evaluation of one-appointment formocresol pulpectomy technique for primary molars. *Pediatr Dent* 7: 123-129.
- [11] Barr ES, Flatz CN and Hicks MJ (1991) A retrospective radiographic evaluation of primary molar pulpectomies. *Pediatr Dent* 13: 4-9.
- [12] Sadrian R and Coll JM (1993) A long-term followup on the retention rate of zinc oxide eugenol filler after primary tooth pulpectomy. *Pediatr Dent* 15: 249-253.
- [13] Holan G and Fuks AB (1993) A comparison of pulpectomies using ZOE and KRI paste in primary molars: a retrospective study. *Pediatr Dent* 15: 403-407.
- [14] Coll JA and Sadrian R (1996) Predicting pulpectomy success and its relationship to exfoliation and succedaneous dentition. *Pediatr Dent* 18: 57-63.
- [15] Mani SA, Chawla HS, Tewari A and Goyal A (2000) Evaluation of calcium hydroxide and zinc oxide eugenol as root canal filling materials in primary teeth. *J Dent Child* 67: 142-147.
- [16] Fuks AB, Eidelman E and Pauker N (2002) Root fillings with Endoflas in primary teeth: a retrospective study. *J Clin Pediatr Dent* 27: 41-45.
- [17] Primosch RE, Ahmadi A, Setzer B and Guelmann M (2005) A retrospective assessment of zinc oxide-eugenol pulpectomies in vital maxillary primary incisors successfully restored with composite resin crowns. *Pediatr Dent* 27: 470-477.
- [18] Hendry JA, Jeansonne BG, Dummett CO and Burrell W (1982) Comparison of calcium hydroxide and zinc oxide and eugenol pulpectomies in primary teeth of dogs. *Oral Surg* 54: 445-451.

- [19] Woods RL, Kildea PM, Gabriel SA and Freilich LS (1984) A histological study of hydron and zinc oxide-eugenol as endodontic filling materials in the primary teeth of dogs. *Oral Surg* 58: 82-93.
- [20] Rosendahl R (1995) Root canal treatment of primary molars with infected pulps using calcium hydroxide as a root canal filling. *J Clin Pediatr Dent* 19: 255-258.
- [21] Cleaton-Jones P, Duggal M, Parak R, Williams S and Setzer S (2004) Zinc oxide-eugenol and calcium hydroxide pulpectomies in baboon primary molars: Histological responses. *Eur J Paediatr Dent* 3: 131-135.
- [22] Murata SS, Holland R, Souza V, Dezan E Jr, Grossi JA and Percinoto C (2005) Histological analysis of the periapical tissues of dog deciduous teeth after root canal filling with different materials. *J Appl Oral Sci* 13: 318-324.
- [23] Fuchino T, Yakushiji M and Machida Y (1978) A clinico-radiographical study of root canal filling in the deciduous teeth with Vitapex. *Jpn J Ped Dent* 16: 360-365.
- [24] Yamada S, Yoshida Y, Morita E, Motokawa W and Sheino T (1979) A study of the root canal filling with Vitapex (1) A radiographic observation in the non-vital primary teeth and permanent teeth with open apices. *Fukuoka Dent Coll Soc J* 6: 111-121.
- [25] Nishino M, Inoue K, Ono Y, Yamaguti Y and Uno K (1980) Clinico-roentogeno- graphical study of iodoform-calcium hydroxide root canal filling material "Vitapex" in deciduous teeth. *Jpn J Ped Dent* 18: 20-24.
- [26] Chiba H, Igari K and Kamiyama K (1981) A long term clinical and radiographical observation of deciduous teeth after root canal filling with Vitapex. *Jpn J Ped Dent* 19: 598-606.
- [27] Nurko C and Garcia-Godoy F (1999) Evaluation of a calcium hydroxide/iodoform paste (Vitapex) in root canal therapy for primary teeth. *J Clin Pediatr Dent* 23: 289-294.
- [28] Nurko C, Ranly DM, Garcia-Godoy F and Lakshmyya KN (2000) Resorption of a calcium hydroxide/iodoform paste (Vitapex®) in root canal therapy for primary teeth: A case report. *Pediatr Dent* 22: 517-520.
- [29] Nedley MP (2002) The pulpectomy in primary teeth. *J Mich Dent Assoc* 84 (8): 38-42.
- [30] Mortazavi M and Mesbahi M (2004) Comparison of zinc oxide and eugenol, and Vitapex for root canal treatment of necrotic primary teeth. *Int J Paediatr Dent* 14: 417-424.
- [31] Özalp N, Şaroğlu I and Sönmez H. (2005) Evaluation of various root canal filling materials in primary molar pulpectomies: An *in vivo* study. *Am J Dent* 18: 347-350.
- [32] Trairatvorakul C and Chunlasikawan S (2008) Success of pulpectomy with zinc oxide-eugenol vs calcium hydroxide/iodoform paste in primary molars: a clinical study. *Pediatr Dent* 30: 303-308.
- [33] Nakornchai S, Banditsing P and Visetratana N (2010) Clinical evaluation of 3Mix and Vitapex® as treatment options for pulpally involved primary molar. *Int J Paediatr Dent* 20: 214-221.
- [34] Shibuya T (1980) A histopathological study in dogs on the improvement of a paste for root canal filling. *Shikwa Gakuho* 80: 417-446.
- [35] Shibuya T, Hori M, Makiishi T, Hirai A, Koga K, Ohsone M, Takahashi K and Ishikawa T (1982) An observation of clinical signs and symptoms, combination with collimated x-ray examination on the root canal filling with Vitapex. *Shikwa Gakuho* 82: 327-333.
- [36] Fujii H and Machida Y (1991) Histological study of therapy for infected nonvital permanent teeth with incompletely formed apices. *Bull Tokyo Dent Coll* 32: 35-45.
- [37] Fujii H, Mizutani T and Machida Y (1985) Clinical and radiographical observation of root canal therapy in permanent teeth with incompletely formed apices. *Jpn J Ped Dent* 23: 33-43.
- [38] Kawakami T, Nakamura C, Hasegawa H, Akahane S and Eda S (1987) Ultrastructural study of initial calcification in the rat subcutaneous tissues elicited by a root canal filling material. *Oral Surg* 63: 360-365.
- [39] Kawakami T, Nakamura C, Hasegawa H and Eda S (1987) Fate of ⁴⁵Ca-labeled calcium hydroxide in a root canal filling paste embedded in rat subcutaneous tissues. *J Endod* 13: 220-223.
- [40] Kawakami T, Nakamura C and Eda S (1991) Effects of the penetration of a root canal filling material into the mandibular canal. 1. Tissue reaction to the material. *Endod Dent Traumatol* 7: 36-41.
- [41] Kawakami T, Nakamura C and Eda S (1991) Effects of the penetration of a root canal filling material into the mandibular canal. 2. Changes in the alveolar nerve tissue. *Endod Dent Traumatol* 7: 42-47.