

Management of intruded primary teeth after traumatic injuries

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Abstract Intrusions occur frequently in the primary dentition. It has been reported that conservative treatment of the intruded primary tooth is preferred if the apex is away from the permanent tooth germ. Conservative treatments include waiting for spontaneous re-eruption, and surgical re-positioning and fixation. Few papers have been published in Japan comparing the prognoses of intruded primary teeth between these two different modes of treatment. Therefore, optimal treatment for intruded primary teeth has been a topic of controversy among clinicians. The aim of this study was to compare the outcomes of intruded primary teeth between these two modes of treatment. Moreover, we examined the issue of treatment of choice for intruded primary teeth. The subjects consisted of 17 children referred to the Hiroshima University Hospital Department of Pediatric Dentistry for the treatment of 21 intruded primary teeth. Fourteen teeth were allowed to spontaneously re-erupt (group W), and 7 teeth were repositioned and fixed (group R). Antibiotic therapy and irrigation were performed in all intruded teeth. Treatment outcomes were evaluated using the following parameters: re-eruption, pathological pulp changes, increased mobility, discoloration, pulp canal obliteration, pathological root resorption, and disturbances of permanent teeth. In group W, root canal treatment or extraction were not performed since re-erupted teeth reveal no signs of infection. On the other hand, in group R, 57% of teeth required endodontic treatment or extracted due to signs of infection. The result showed treatment outcomes in group R were worse than those in group W. Our study indicates that most intruded primary teeth re-erupt with a favorable prognosis. Therefore, observation with irrigation and antibiotic therapy should be the treatment of first choice.

Key words
Intrusion,
Management,
Primary teeth,
Traumatic injuries,
Treatment

Introduction

The type of dental injury that occurs following trauma to the oral cavity appears to be related to whether the dentition is permanent or primary¹. In permanent dentition, tooth fractures seem to be more common, whereas in primary dentition, luxations dominate^{1,2}. Intrusions occur frequently in the primary dentition¹.

In cases where the root apex of an intruded primary tooth is pushed against the permanent tooth germ, risking severe damage to the permanent tooth, the intruded primary tooth should be extracted immediately³⁻⁶. However, it has been reported that conservative treatment of the intruded primary tooth is preferred if the apex is away from the permanent tooth germ³. Conservative treatments include (1) waiting for spontaneous re-eruption, and (2) surgical re-positioning and fixation⁷.

However, few papers have been published in Japan comparing the prognoses of intruded primary

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Table 1 Results of the evaluation items in group W

age/sex	number of teeth	degree of intrusion	degree of re-eruption	oral habits	pathological pulp changes	increased mobility	discoloration	pulp canal obliteration	root resorption	disturbances of permanent teeth	treatment
1y6m/m	61	full	full (1y10m)	-	-	-	-	(2y5m)	-	unexfoliation (5y11m)	-
1y2m/f	51	full	full (1y5m)	-	-	-	-	(2y2m)	-	- (7y6m)	-
2y3m/m	61	2/3	full (3y7m)	thumb sucking	-	-	-	-	(3y8m)	- (7y9m)	-
3y2m/f	61	2/3	full (4y0m)	thumb sucking tongue thrust	-	-	-	-	(3y6m)	white or yellow-brown discoloration of enamel(6y8m)	-
2y8m/m	51	1/2	full (3y2m)	-	-	-	yellow (4y9m)	-	(2y9m)	white discoloration of enamel with circular enamel hypoplasia (7y8m)	-
1y7m/m	51	1/3	full (1y8m)	-	-	-	yellow (1y7m)	(3y5m)	(3y5m)	- (6y7m)	-
1y9m/f	51	1/3	full (2y6m)	-	-	-	yellow (2y0m)	(2y5m)	(4y8m)	- (8y3m)	-
3y5m/f	51	1/2	full (4y1m)	-	-	-	-	-	-	unexfoliation (5y3m)	-
	61	1/3	full (3y7m)	-	-	-	gray (3y6m)	-	-	unexfoliation (5y3m)	-
	51	full	full (4y0m)	-	-	-	-	-	(4y11m)	unexfoliation (6y7m)	-
3y11m/m	52	full	full (4y0m)	-	-	-	-	(4y11m)	-	unexfoliation (6y7m)	-
	53	full	full (4y0m)	-	-	-	-	-	-	unexfoliation (6y7m)	-
	61	full	full (4y0m)	-	-	-	-	-	(4y11m)	unexfoliation (6y7m)	-
2y4m/f	51	full	partially (2y10m)	-	-	-	yellow (2y10m)	-	(2y10m)	unexfoliation (5y2m)	-

teeth between these two different modes of treatment. Therefore, optimal treatment for intruded primary teeth has been a topic of controversy among clinicians.

The purpose of this study was to compare the outcomes associated with these two modes of treatment for intruded primary teeth retrospectively. The first method of treatment includes waiting for spontaneous re-eruption, and the second method of treatment includes repositioning of the intruded primary teeth.

Moreover, we examined the issue of optimal treatment for intruded primary teeth.

Subjects and Methods

Subjects

The subjects were 17 children referred to Hiroshima University Hospital Department of Pediatric Dentistry for the chief complaint of intruded primary teeth associated with trauma to the oral cavity. These children presented with a total of 21 intruded primary teeth, which were divided into 2 groups:

14 teeth were assigned to group W (no repositioning or fixation; patients were treated with oral irrigation and antimicrobial medications), and 7 teeth were assigned to group R (reposition and fixation were performed.) In group R, 6 out of 7 teeth had already been repositioned and fixed at the first visit. One tooth was repositioned in our hospital. In all teeth, x-ray radiographic demonstration of displacement of the permanent tooth germ following intrusion of the primary tooth was not founded.

Evaluation methods

Teeth were evaluated for the following criteria with dental records, x-ray radiographic examination, and intraoral color photos.

1) Evaluation criteria collected at the first visit

Evaluation criteria collected at the first visit were age at the time of injury, sex, number of teeth intruded, degree of intrusion (full, 1/3 of the crown, 1/2 of the crown, and 2/3 of the crown), and oral habits.

2) Evaluation criteria collected at follow-up visits

Twenty-one intruded primary teeth were followed

Table 2 Results of the evaluation items in group R

age/sex	number of teeth	degree of intrusion	oral habits	pathological pulp changes	increased mobility	discoloration	pulp canal obliteration	root resorption	disturbances of permanent teeth	treatment
3y5m /f	51	full	thumb sucking	abscess formation (3y7m)	(3y8m)	-	-	-	white or yellow-brown discoloration of enamel (7y2m)	extraction (3y8m)
1y6m /f	51	1/3	-	abscess formation (2y6m)	-	yellow (2y3m)	-	-	white or yellow-brown discoloration of enamel (7y9m)	RCT (2y6m)
1y11m /f	61	1/3	thumb sucking	-	-	yellow (2y1m)	-	(3y8m)	exfoliation of only crown edge (7y3m)	-
1y11m /m	61	1/2	thumb sucking tongue thrust	radiolucency (2y3m)	-	yellow (1y11m)	-	(3y6m)	unexfoliation (61 shedding) (6y1m)	RCT (2y3m)
2y9m /f	51	1/2	thumb sucking	-	-	yellow (3y0m)	-	(2y9m)	- (7y5m)	-
1y7m /m	51	1/2	thumb sucking	-	(4y1m)	-	-	(1y10m)	unexfoliation (4y1m)	-
2y4m /m	51	2/3	thumb sucking	-	(2y11m)	-	-	(2y11m)	unexfoliation (2y11m)	RCT (2y11m)

up for a period between 1 and 6 years. Outcomes were evaluated based on the following findings:

a) Re-eruption

In group W, the degree of re-eruption (full or partial) were examined.

b) Pathological pulp changes

Pathological pulp changes were recorded when intruded primary teeth were diagnosed with pulpitis, pulp necrosis, and apical periodontitis based on the presence of abscess, fistula, radiolucency in the apical region, spontaneous pain, and/or percussion pain.

c) Increased mobility

Increase in mobility was recorded when abnormal mobility was present.

d) Discoloration

Discoloration was recorded when color change of the crown was observed in a color photo or in the dental records.

e) Pulp canal obliteration (PCO)

X-ray radiographic diagnosis of narrowing of the pulp cavity was defined as pulp canal obliteration.

f) Pathological root resorption

Pathological root resorption was noted in cases where x-ray radiographs provided evidence of root resorption earlier than that would be expected due to normal physiologic development. According to a report by Mc-Bride⁸⁾, the ages when physiological resorption starts is 5-, 6- and 8-year-old for primary central incisors, primary lateral incisors, and primary canines, respectively. The type of pathological root resorption of could be superficial, replacement and inflammatory resorption. In this paper, there was no description of type of pathological root resorption.

g) Disturbances of permanent teeth

In keeping with the classifications proposed by Andreassen³⁾, disturbances of permanent teeth were investigated and classified as the following: white or yellow-brown discoloration of enamel, white or yellow-brown discoloration of enamel with circular enamel hypoplasia, crown dilacerations, odontoma-like malformation, root duplication, vestibular root angulation, lateral root angulation or dilacerations, partial or complete arrest of root formations, and sequestration of permanent tooth germs.

h) Subsequent treatment

Whether the subject required additional treatment and the recorded details.

Results

Results of the evaluation items are shown in Tables 1 and 2. The year/month in parenthesis express the child's age. Distribution of sequelae in both groups are shown in Table 3.

1. Evaluation items on the first visit

The subjects' ages at the time of injury were between 1 year and 2 months and 3 years and 11 months with a mean age of 2 years and 7 months. The boy/girl ratio was 8:9. There was no significant difference in gender between both groups statistically (Fisher's exact test). Twenty of the intruded primary teeth were maxillary primary incisors, and 1 was a maxillary primary canine. As to the degree of intrusion, 8 teeth (38%) were fully intruded and 13 teeth (62%) were partially intruded. Of partially intruded teeth, the degree of intrusion was 1/3 of the crown length in 5 teeth (38%), the degree of intrusion was 1/2 of

Table 3 Distribution of sequelae in both groups

group	pathological pulp changes	increased mobility	discoloration	pulp canal obliteration	pathological root resorption
	n (%)	n (%)	n (%)	n (%)	n (%)
W (n = 14)	0 (0)	0 (0)	5 (36)	5 (36)	8 (57)
R (n = 7)	3 (43)	3 (43)	4 (57)	0 (0)	5 (71)
total (n = 21)	3 (14)	3 (14)	9 (43)	5 (23)	13 (62)

crown length in 5 teeth (38%), and the degree of intrusion was 2/3 crown length in 3 teeth (23%). Of 17 children, 8 children had one of the following oral habits: thumb sucking, or tongue thrust.

2. Evaluation items on follow-up

1) Re-eruption

In group W, all intruded primary teeth started to re-erupt within 4 months after injury. Thirteen intruded teeth re-erupted to the occlusal position, and 1 intruded tooth stopped re-erupting at a position 1.5 mm lower than the occlusal plane. The number of intruded primary teeth was not a significant factor influencing the ability of the teeth to re-erupt.

2) Pathological pulp changes

In group W, no abscess, fistula, translucency in the apical region on x-ray photograph, spontaneous pain, or percussion pain was observed. In group R, 3 of 7 intruded teeth (43%) showed signs suggesting pathological pulp changes such as alveolar abscess formation, periapical periodontitis on x-ray photograph. Alveolar bone abscess was observed in 2 teeth (29%), and translucency in the apical region on x-ray photograph was observed in 1 tooth (14%).

3) Increased mobility

In group W, no teeth showed increased mobility. In group R, 3 teeth (43%) showed increased mobility.

4) Discoloration

In this study, coronal discoloration was seen in 9 teeth (43%) from the 2 groups. In group W, discoloration was observed in 5 teeth (36%). Four of them (80%) presented with yellow discoloration and 1 tooth (20%) presented with gray discoloration. In group R, discoloration was observed in 4 teeth (57%). All of these showed yellow discoloration.

5) PCO

In group W, 5 teeth (36%) presented with PCO. In group R, no teeth presented PCO.

6) Pathological root resorption

In the present study, 13 out of 21 teeth (62%)

developed external root resorption. No internal root resorption was observed. In group W, 8 teeth (57%) developed external root resorption. In group R, 5 teeth (71%) developed external root resorption.

7) Disturbances of permanent teeth

During the follow-up period, we observed the emergence of 9 successors to the intruded primary teeth. Four out of 9 successors of intruded primary teeth (45%) showed white or yellow-brown discoloration of enamel and horizontal enamel hypoplasia. In group W, developmental disturbances were noted in 2 of 6 successors (33%) following intrusion of their primary counterparts. In 1 tooth, white or yellow-brown discoloration of enamel was observed. In the other, horizontal enamel hypoplasia was observed. In group R, white or yellow-brown discoloration of enamel was observed in 2 out of 3 successors (67%) following intrusion of their primary counterparts. In both groups, developmental disturbances, other than white or yellow-brown discoloration of enamel and horizontal enamel hypoplasia, were not found.

8) Subsequent treatment

In group W, none of the teeth required subsequent treatment. In group R, 4 of 7 intruded teeth (57%) required endodontic treatment or extraction due to signs suggesting pulp infection such as alveolar abscess formation, periapical periodontitis on x-ray radiograph, or increased mobility. Three teeth required subsequent endodontic treatment and 1 tooth required extraction.

Discussion

It has been reported that the peak incidence of the intrusion of primary teeth is between 1 and 3 years old⁹⁾. In the present study, the age at the first visit for intrusion was between 1 year and 2 months and 3 years 11 months. This age range is similar those previously reported⁹⁾. In other previous reports, the rate of primary tooth injury was shown to be higher

in boys²). However, the boy/girl ratio in the present study was 8:9, suggesting a slightly higher rate in girls. Twenty of the injured teeth were upper primary incisors and 1 was an upper primary canine. The upper frontal teeth are considered to be the most prone to injury, since falls are the most frequent cause of injury to primary dentition²).

Re-eruption

Holan *et al.*^{4,6} proposed that the degree of intrusion is not a significant factor influencing the ability of the teeth to re-erupt. In Holan *et al.*'s study⁶, 109 of 123 intruded teeth (88%), including complete intrusions, re-erupted fully. They also reported that the position of the teeth after re-eruption is not influenced by the degree of intrusion^{4,6}. In group W, all teeth re-erupted spontaneously even in cases of full intrusion. No clear relationship was observed between the degree of intrusion and infraocclusion, rotation, or inclination.

While some authors have reported that failure to re-erupt to the occlusal plane is often associated with pacifier use, thumb sucking, or tongue thrust^{4,6}, in our study all of the intruded primary teeth re-erupted spontaneously even in the presence of thumb sucking or tongue thrust. These results suggest that most intruded primary teeth re-erupt without treatment, and regardless of oral habits.

Pulp infection

In group W, no endodontic treatment was required since re-erupted teeth did not reveal any signs of pulp infection, such as alveolar bone abscess formation, fistula, or periapical periodontitis. On the other hand, in group R, 4 of 7 intruded teeth (57%) required endodontic treatment or extraction due to signs suggesting pulp infection such as alveolar abscess formation or periapical periodontitis on x-ray radiograph, or increased mobility. These results indicate that the intruded primary teeth in group R showed a poorer prognosis than those in group W.

It is believed that the incidence of pathological pulp changes after injury is high in cases of serious dislocation^{10,11}). However, it has also been reported that the incidence of pathological pulp changes is low in intruded teeth after re-eruption¹⁰). Miyashin *et al.*¹⁰ reported that this is because the wide apical foramen in immature teeth allows for abundant blood circulation in the pulp, which helps intruded teeth avoid necrosis. Possible reasons for the poor prognosis in group R include following:

- It is difficult to keep re-positioned teeth calm because few anchor teeth are available for fixation in very young children.
- Intruded teeth are re-injured in the process of re-position, which causes infection.

Rock¹²) reported that repositioning of lateral luxations was associated with an increased risk of developing pulp necrosis.

These results suggest that the incidence of pathological pulp changes in re-erupted teeth is low when intruded primary teeth are monitored and treated with irrigation and antimicrobial medication, and that repositioning and fixation treatment increases the risk of pulp necrosis.

Discoloration

In this study, coronal discoloration was seen in 9 teeth (43%) from the 2 groups. Two out of 9 teeth (22%) with coronal discoloration developed abscess formation or radiolucency on x-ray radiograph. No association was noted between the degree of intrusion and the level of discoloration. McDonald and Avey¹³) believed that the pulp of primary teeth discolored after trauma should be removed immediately to prevent the development of pulp necrosis. In contrast, Borum¹⁴) argued that pulp necrosis cannot be diagnosed solely by discoloration, since 25% of the permanently gray discolored teeth in his study remained without other pathological symptoms throughout the follow-up period, and 25% of the teeth with no color changes in his study showed pulp necrosis. Andreasen *et al.*³) also demonstrated that discoloration of a primary tooth after luxation should not be used as the only criterion for interceptive pulpal therapy. Further, we propose that the discoloration of re-erupted primary teeth should not be used as the sole criterion for recommending endodontic treatment.

PCO

Holan *et al.*⁶) demonstrated that 52% of re-erupted primary teeth developed PCO. PCO is the common complication of the trauma¹²). A late complication following PCO is the development of pulp necrosis and the occurrence of periapical changes³). In the present study, no teeth with PCO required treatments because no signs of infection appeared during the follow-up period. According to Jacobsen¹⁵), primary teeth with PCO do not hamper the eruption of successive teeth. Borum *et al.*¹⁴) reported that there was no correlation between PCO and the rate of

physiological root resorption. Therefore we propose that primary teeth with PCO should be observed unless there are clear signs of pulp infection.

Pathological root resorption

In the present study, 13 out of 21 teeth (62%) were diagnosed with abnormal root resorption since root resorption was confirmed earlier than physiological root resorption. Among these 13 teeth, 11 did not show any signs of infection or abnormal positioning of successive permanent teeth during the follow-up period. Two of the teeth required endodontic treatments due to signs of pulp infection. No eruption disturbance was confirmed in any of the 4 successive permanent teeth that were examined.

These results suggest that observation should be the first treatment choice to assess abnormal root resorption in injured teeth unless infection, or abnormal positioning of successive permanent teeth occurs.

Pulp necrosis

Pulp necrosis is suspected when discoloration or root resorption is observed in injured teeth. Holan *et al.*⁴⁾ however, found that more than half of the intruded primary teeth in their study preserved their vitality. This report and our findings suggested following:

- Discoloration, PCO, and root resorption of injured primary tooth should not be used as criterion for interceptive pulpal therapy.
- Injured necrotic teeth can often be preserved without affecting their surroundings because, unlike cases involving caries, necrosis in these cases is sterile.

The diagnosis of pulp necrosis should be confirmed by using electric pulp testing (EPT), laser doppler flowmetry (LDF), x-ray radiograph, symptoms such as spontaneous pain or tenderness to percussion. However, EPT is not reliable especially in the primary dentition and LDF is costly and needs further refinement before it can be of general clinical value.

Disturbances of permanent teeth

In our study, 4 out of 9 successors of intruded primary teeth (45%) showed white or yellow-brown discoloration of enamel and horizontal enamel hypoplasia. Severe developmental disturbances such as root angulation or dilaceration, however, did not occur. Also, the primary counterparts of the 2 discolored permanent teeth did not show any signs

of pulp infection or abnormal positioning of successive permanent teeth during the follow-up period. Andreasen *et al.*¹⁶⁾ reported that there was an insignificant difference in the extent and frequency of developmental disturbances associated with intruded teeth extracted immediately versus those that had been preserved. We suggest that damage to successive permanent teeth may occur at impact, and that treatment of primary teeth does not prevent damage to the underlying permanent teeth.

These results suggest that most intruded teeth spontaneously re-erupt and show a favorable prognosis. The number of intruded primary teeth was not a significant factor influencing the ability of the teeth to re-erupt. Therefore the optimal treatment for intruded primary teeth involves waiting for spontaneous re-eruption while performing irrigation and administering antimicrobial medications, so long as injury to the developing germ of the permanent successor is not suspected. Clinical and radiographic follow-up should be performed regularly so that pulp infection of the intruded primary teeth and disturbances of permanent teeth are not overlooked. It is important that dentist informs parents about necessity of periodic follow-ups and gets consent from them.

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