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ORIGINAL ARTICLE

A retrospective study of traumatic dental injuries in primary dentition: treatment outcomes of splinting

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ABSTRACT

Objective: Splinting in primary dentition is limited to several traumatic dental injuries. The prognosis associated with splint use has not been fully investigated. In this study, we investigated the outcomes of traumatic injuries in primary teeth treated with splinting.

Materials and methods: We retrospectively analysed 137 children with root fractures and lateral and extrusive luxation injuries to their primary teeth who were treated with semi-rigid splints between 2010 and 2016. Treatment outcomes were analysed in patients with follow-up periods of >6 months. The outcomes of splinting were based on clinical and radiographic evaluations performed during follow-up examinations.

Results: In total, 182 primary teeth were examined, and of these, 90 teeth were treated using semi-rigid splints. In the splint group, pathological root resorption (31.1%) was the most common complication, whereas pathological tooth loss (25.0%) was found most common in the observation group. Splinting in root fractures showed a good prognosis, whereas in lateral and extrusive luxations, it did not ($p < .05$). There were no relationship between treatment delay and prognosis ($p > .05$).

Conclusions: Depending on the type of luxation, splint therapy results in acceptable outcomes and may be a feasible treatment option.

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Splints; primary dentition; luxation injury; traumatic dental injury

Introduction

Traumatic dental injuries (TDI) are common in the primary dentition, occurring more often than in the permanent dentition. This is due to children's poor motor coordination, and is sometimes related to their lack of judgment regarding potential risks. Various trauma-related injuries are possible, depending on the force and direction of impact. Because of this varied aetiology, treatment methods vary according to the type of injury [1].

One treatment method for traumatized teeth is tooth splinting, which allows periodontal tissue healing while protecting the tooth from further injuries. Flexible or semi-rigid fixation is sufficient for pulp and periodontal healing in most TDIs, and rigid fixation is only recommended for cervical root fractures [1–3]. If ankylosis is not a significant risk, 1–2 weeks is recommended for the fixation period. However, if traumatic injuries include destruction of the bone, 1–2 additional weeks may be required, and for root fractures, up to 4 months of immobilization may be needed [1,4].

The International Association for Dental Traumatology (IADT) guidelines recommend splinting of the primary dentition only in cases of alveolar bone and root fractures [5]. This is because the treatment of TDIs in the primary dentition should be aimed at minimizing additional damage to the permanent successors [1].

Although TDIs in primary dentition have been emphasized, few studies have been conducted on this topic. Moreover, most studies concern the epidemiology of dental trauma in the primary dentition, not outcomes of different treatments. Recently, however, trials involving splinting of traumatized primary teeth following alveolar process fractures, horizontal root fractures and lateral luxation have been reported [6–9]. To advance our knowledge about TDIs in the primary dentition, such trials are important and should be continued. The purpose of this study was to evaluate the outcomes of traumatic dental injuries following splinting of traumatized primary teeth.

Materials and methods

All patients who visited the Department of Paediatric Dentistry, School of Dentistry, Kyung Hee University, Seoul, Korea, for the treatment of TDI in the primary dentition between January 2010 and June 2016 were assessed. Only patients with splint indications, such as root fractures, lateral luxation and extrusive luxation, were considered for inclusion in the study. Exclusion criteria were genetic disorders, no additional traumatic injury to the teeth and a follow-up

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period <6 months. The study proposal was reviewed and approved by the ethics committee of Kyung Hee Medical Center Kyung Hee University, Seoul, Republic of Korea (KHD IRB 1606-4).

Among total of 838 patients (1534 teeth) visited our department for the treatment of luxation injuries of their primary teeth, 137 patients (182 teeth) were selected for re-evaluation. In selected patients, 64 patients (90 teeth) were treated with splinting and the main reason was fine cooperation of patients and their parent's wish to solve the mobility of injured teeth. Splint group were treated with flexible round stainless steel wire (SS-GFS; Ormco Corp., Orange, CA) and flowable composite resin. Time of splinting depended on factors, such as persistence of increased mobility, kind of trauma and interference of nutritional habits.

Clinical data, such as gender, arrival time after trauma, type of TDI, type of treatment and complications after trauma, were collected. Consecutive radiographs were also collected to evaluate the outcomes of TDIs. Outcomes were categorized into two groups: clinical success when the traumatized teeth were maintained and clinical failure when the traumatized teeth needed further treatment. These outcomes were based on the presence of associated complications on clinical and radiographic examinations at follow up check. Clinical success included discoloration, total or partial pulp canal obliterations and a lack of complications. Clinical failure included pulp necrosis, pathological root resorption, pathological loss of teeth, ankylosis and pathological bone resorption [1,10]. The definition of early loss of primary teeth was extraction due to later complications following other types of injury. For analysis of prognosis according to arrival time after trauma, patients with splint therapy were divided into two groups: arrival at or before and arrival after 24 h from the trauma.

To remove side effects from other factors, all patients' guardians were advised regarding care of the traumatic injured teeth and the prevention of additional trauma. Parents and guardians were received document about keeping good oral hygiene. In document, the contents were brushing with a soft brush and use of 0.1% chlorhexidine topically on the affected area for 1 week to prevent accumulation of plaque. Also, 10 d of soft diet, restriction of bad habits, such as thumb sucking, touching and using an intraoral pacifier are recommended.

To determine the statistical significance of data, Fisher's exact test was used, and p Values <.05 were considered to indicate statistical significance. Statistical analyses were performed using the SPSS software version 22 for Windows (IBM Corp., Armonk, NY).

Results

In total, 137 patients (182 teeth) were included in this study. The study population consisted of 89 boys and 48 girls, a sex ratio of 1.85:1. The average patient age was 41.1 ± 15.6 months, and the most prevalent age was 4–5 years, followed by 3–4 years. Of the patients, 38 (53 teeth) experienced root fracture, 84 (107 teeth) experienced lateral luxation and 15 (22 teeth) experienced extrusive luxation (Table 1).

Patients were divided by type of TDIs and use of splints. Among the 137 patients, 64 (90 teeth) were treated using semi-rigid splints, while 73 (92 teeth) were not splinted. The distribution of complications is shown in Figure 1. In the splint group, pathological root resorption (31.1%) was the most common complication, and pathological tooth loss (25.0%) was the mostly found complication in the observation group during the follow-up period.

A comparison of prognoses among the different treatment groups for each type of TDI revealed a statistically significant difference only between the groups with root fractures ($p = .012$; Table 2). The splinted group was 4.67 times more likely to have a clinical success than the observation group (odds ratio =4.67, 95% confidence interval, CI =1.406–15.484, $p = .012$).

The prognosis for the early arrival group was better prognosis than that for the late group. However, the difference was not statistically significant ($p > .05$; Table 3).

Discussion

TDIs in the primary teeth have a prevalence of approximately 30–40% [6,11–13]. Despite this large number of cases, most studies have concerned epidemiology and few have focused on treatments and prognoses [12].

Table 1. Distribution of patients according to type of TDI and gender.

	Male	Female	Total
Root fracture	30 (78.9%)	8 (21.1%)	38
Lateral luxation	51 (65.4%)	33 (34.6%)	84
Extrusive luxation	8 (53.3%)	7 (46.7%)	15
Total	89 (65.0%)	48 (35.0%)	137

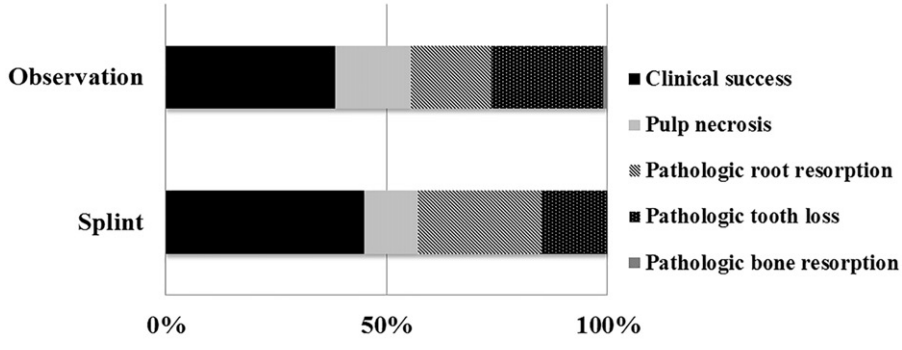

Figure 1. Distribution of complications according to the type of treatment.

Treatment of TDIs in the primary dentition differs from that in the permanent dentition. It is often difficult to examine and treat young child in a fearful situation. However, untreated TDIs may lead to poor a prognosis, such as early tooth loss, and this may affect the child functionally and psychologically [1].

TDIs in the primary dentition can cause clinical complications, including colour changes, pulp necrosis, pulp canal obliteration and external or internal root resorption [1]. Clinical success and failure were identified based on literature reports [10,14]. According to Flores [12], discoloration may not be associated with pulp necrosis. Thus, unless associated infection is present, root canal treatment is not recommended in discoloured teeth. Also, the frequency of secondary pulp necrosis among teeth with pulp canal obliteration is low [1,10,15,16]. Thus, in this analysis, discoloration and pulp canal obliteration were considered as examples of clinical success. Clinical failure included pulp necrosis, pathological root resorption, pathological loss of teeth and pathological bone resorption.

The repositioning of a traumatized tooth with an injured periodontal ligament may increase the pressure that already exists on the nutritive vessels to the tooth, increasing the chances of ischemia and necrosis [17]. This may lead to abandoning splinting in luxation. However, according to Flores [12], a splint following reposition may be selected as a treatment when occlusal interference exists in luxated teeth. That is, occlusal interference can put injured teeth in a dangerous situation and lead to a worse prognosis. Although repositioning is priority in luxated injuries, without fixation with splint, traumatized teeth may still be mobile and occlusal interference could happen again. This study, in teeth with lateral and extrusive luxation, there was no statistically significant difference in prognosis among treatment types. This may be because, although forced repositioning may induce unwanted pulpal necrosis, a splint may prevent further trauma from occlusion, so together, they may make the prognosis no worse. Moreover, splinting can decrease initial tooth mobility and associated pain, and may prevent children from touching their mobile teeth[7]. Thus, splinting in luxated teeth can be recommended as an option for treatment.

Unlike the luxation group, there was a statistically significant difference between types of treatment and prognosis in the root fracture group. Root fractures in the primary dentition are usually located at mid-root or in the apical third [1,18]. Because the apical fragment stays at the same position, essentially uninjured, treatment may not be needed for this part [10]. The coronal fragment, however, is often displaced, with resulting trauma to the PDL and neurovascular supply to the coronal pulp; thus, injury to this part may be considered as a luxation injury. However, unlike a luxation injury, the coronal fragment has a shorter root, which is less resistant to additional trauma and dental habits. Thus, in root fracture cases, it is advisable to reposition and splint the coronal fragment to prevent additional traumatic injuries. In this study, splinting showed a better prognosis in the root fracture group; based on this result, splinting may be recommended.

In this study, pathological root resorption was the most common complication in the splint group. Pathological root resorption is a radiographic failure that can lead to early tooth extraction. There are many classifications and terms for different types of root resorption, such as inflammatory root resorption and replacement root resorption in permanent teeth [19]. However, current knowledge about the types of pathological root resorption in permanent teeth is not transferable to primary teeth [10]. For primary teeth, apart from pathological root resorption, the permanent successors may resorb the root of primary teeth, which, in terms of physiological root resorption and overlapping structures, may prevent an accurate diagnosis. Also, Rubel [20] claimed that digit sucking may be associated with atypical radicular resorption, even with no identified dental trauma. To diagnose pathological root resorption precisely, regular clinical and radiographic exams are needed, and this diagnosis becomes more accurate as more radiographic exams are performed [21]. However, even with the aid of radiographic exams, it is difficult to distinguish pathological root resorption from other root resorption types; thus, splinting cannot be deemed a major cause of root resorption in teeth with TDIs.

In previous studies, reports about poor outcome, such as pulp necrosis and root resorption, are often found in patients with delayed or no treatment after dental trauma [22,23]. This observation has led to the idea that all dental injuries are worsened by treatment delay, so TDIs need acute treatment. In this study, however, there was no significant difference in prognosis in the delayed treatment group, so early treatment after trauma showed no benefit in terms of prognosis. This is consistent with a study by Al-Nazhan et al. [23], which showed no relationship between treatment delay and traumatic injuries in primary teeth. The only recommendation in primary teeth is to treat regardless of time delay, unless occlusal problem have occurred due to tooth displacement.

Table 2. Postoperative prognosis according to type of treatment.

		Prognosis		
	Total	Success	Failure	*p* value
Root fracture				
Observation	20	6 (30.0%)	14 (70.0%)	.012*
Splinting	33	22 (66.7%)	11 (33.3%)	
Lateral luxation				
Observation	65	25 (38.5%)	40 (61.5%)	.839
Splinting	42	15 (35.7%)	27 (65.3%)	
Extrusive luxation				
Observation	7	4 (57.1%)	3 (42.9%)	.054
Splinting	15	2 (13.3%)	13 (86.7%)	

*Fisher's exact test ($p < .05$).

Table 3. Postoperative prognosis according to treatment delay.

		Prognosis		
	Total	Success	Failure	*p* value
Root fx.				
≤24 h	14	11 (78.6%)	3 (21.4%)	.278
>24 h	19	11 (57.9%)	8 (42.1%)	
Lat. lux.				
≤24 h	29	12 (41.4%)	17 (58.6%)	.314
>24 h	13	3 (23.1%)	10 (76.9%)	
Ext. lux.				
≤24 h	14	2 (14.3%)	12 (85.7%)	1.000
>24 h	1	0 (0.0%)	1 (100.0%)	

*Fisher's exact test.

In such cases, an acute approach should be taken to relieve symptoms [22,24,25].

This study has some limitations. First, severity of trauma was not measured precisely. Although grouped in same type of trauma, prognosis may be differed according to the severity of trauma. The reason for the result showing no relationship between treatment delay and prognosis is unknown; however, this may be due to the small data set and possibly to differences in the degree of injury. Moreover, in primary teeth with TDIs with pathological mobility, additional trauma caused by dental habits, such as finger sucking, touching or biting with the traumatized teeth, may have more effect on the prognosis of TDIs in the primary dentition. Thus, there is a need for further studies to investigate the effects of treatment delay on injured teeth treated with splints.

Conclusions

In conclusion, this study demonstrated that splinting in primary teeth with root fractures showed a favourable prognosis. Although splinting did not show a better prognosis in luxation injuries, a splint may also be the treatment of choice for preventing further trauma in such injuries. Thus, depending on the type of luxation, splint therapy ensures an acceptable outcome and may provide a feasible treatment option.

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Disclosure statement

The authors report no conflicts of interest.

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