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A 3-Year Retrospective Study of Traumatic Dental Injuries to the Primary Dentition

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Abstract

Background/Aims

Traumatic dental injuries (TDIs) in the primary dentition are a significant public health problem, which has been neglected worldwide. Despite its high prevalence, limited studies address this injury. The aim of this study was to determine the characteristics and treatment modalities of TDIs affecting primary teeth, along with accompanying medical co-morbidities and attendance at follow-up appointments.

Material and Methods

This retrospective analysis included all TDIs affecting primary teeth from January 2014 to January 2017. Data abstraction included demographics, time lapse prior to arrival at hospital, trauma etiology, classification of TDIs, soft tissue and supporting bone injuries, medical co-morbidities, emergency treatment, follow-up appointments and prognosis.

Results

Records of 283 children with 536 traumatized primary teeth were reviewed. The median age was 2 years and the maxillary right central incisor (35.1%) was the most frequently injured tooth. Almost half the patients, 46.3%, sought treatment after 24 h. Periodontal tissue injuries (97.2%) predominated TDIs for which fall accidents (82.0%) were the most encountered cause. Most patients (177/283) had accompanying soft tissue/supporting bone injuries and 67.2% had multiple traumatized teeth. Seventy percent of the patients were examined only or were prescribed medication. Survival time following TDIs was unknown in 67.7% of traumatized teeth due to non-attendance at follow-up appointments. Most patients (55.1%) did not attend the follow-up appointments.

Conclusions

TDIs occurred in the primary dentition with the predominance of periodontal tissue injuries. When TDI was the presenting problem to hospital, accompanying systemic injury was rare. Treatment modalities were mostly limited to examination or extraction. The follow-up appointments were poorly attended.

1 INTRODUCTION

Traumatic dental injuries (TDIs) in the primary dentition are common clinical and public health problems that have a significantly higher incidence than in the permanent dentition. This difference may be due to children's inability to assess potential trauma risks or their underdeveloped motor coordination.¹ Approximately 50% of the children, aged 5 to 18 years, will have different types of dental trauma during their school years. These may be associated with serious physical injury and psychological impact for both the patient and the parents.^{2, 3}

A recent profile analysis of the six foremost pediatric dental journals revealed that between 2000–2010, only 1.0% of the published articles were related to primary dentition injuries.⁴ A 15-year bibliometric analysis of dental traumatology also showed that the most common topics were etiology/frequency/cause (36.8%), treatment (30.9%), and prognosis (19.7%).⁵ In that study, the authors stated that the proportion of articles regarding TDIs in the primary dentition had increased but it remained inadequate considering the importance of the condition on children's health.⁵

Patients with primary teeth trauma should be followed longitudinally due to the close relationship of the primary teeth with the underlying permanent successors, which may cause serious consequences by the initial trauma or further sequelae such as infection.⁵⁻⁸ Despite the high prevalence and importance of pediatric dental trauma,¹ follow-up appointment attendance has not been evaluated for primary teeth injuries in the literature so far.

The literature also provides no study emphasizing medical co-morbidities (e.g., brain concussion or loss of consciousness) that could be associated with dental trauma. Therefore, the aim of this retrospective study was to determine the characteristics of TDIs in the primary dentition, their treatment modalities and accompanying medical co-morbidities. The rate of attendance at post-trauma follow-up appointments was also evaluated.

2 MATERIAL AND METHODS

This study was a retrospective data analysis of patients with primary tooth trauma who were referred to Nationwide Children's Hospital (NCH), Columbus, Ohio, USA, between January 2014 and January 2017. The study protocol was reviewed and approved by the Institutional Review Board of NCH (IRB16-01257).

All traumatic dental injuries affecting primary teeth, both during (day clinic, operational during working hours) and outside of clinic hours [urgent care (UC)/emergency department (ED)], were considered for inclusion in the study. The data regarding injuries involving permanent teeth and primary teeth injuries with missing information were excluded.

The data was extracted from the electronic patient records (Epic Systems Corp.) and the detailed information about the injury included the time interval between the trauma and arrival at the hospital, cause of trauma, classification of TDI as hard dental tissue injuries (enamel fracture, enamel-dentin fracture, complicated crown fracture, crown-root fracture, root fracture) and periodontal tissue injuries (concussion, subluxation, extrusive luxation, lateral luxation, intrusive luxation, avulsion),⁹ soft tissue and supporting bone injuries, medical co-morbidities, emergency treatment, follow-up appointments and prognosis. One trained researcher (BO) extracted the data using established criteria and entered it into an Excel database (Microsoft Inc.). Statistical analysis was performed using Statistical Package for Social Science 20.0 software (IBM Corp.).

3 RESULTS

Out of 747 patients, 283 patients (37.9%) with 536 traumatized primary teeth were included in this study. The other 464 patients with permanent teeth injuries were excluded. At the time of injury, the mean and median age of the patients was 3 ± 1.72 and 2 years, respectively. Table 1 presents the age distribution of patients (ranging from 7 months to 11 years) with regard to the type of injuries and the dental arches. The peak age was 2 years old, and the male to female ratio was 1.5:1.

TABLE 1. Distribution of age according to the type of injuries and dental arches

Age (Years)	Patients (N)	HDTI		PTI		HDTI + PTI		(HDTI + PTI) + STI	
		Maxilla	Mandible	Maxilla	Mandible	Maxilla	Mandible	Maxilla	Mandible
≤1	14	3	0	16	8	3	0	0	0
1 < x < 2	64	27	2	53	8	24	2	10	1
2	67	27	0	38	3	24	0	11	0
3	45	11 ^a	4 ^a	41 ^a	5 ^a	11 ^a	4 ^a	8 ^a	4 ^a
4	41	12	0	36	3	10	0	6	0
5	23	4	1	22 ^b	3 ^b	4	1	3	0
6	19	4	0	16 ^a	3 ^a	3	0	2	0
7 ≤ x ≤ 11	10	1	0	8 ^b	3 ^b	0	0	0	0
Total (N)	283	89	7	230	36	79	7	40	5

Abbreviations: HDTI, Hard dental tissue injury; PTI, Periodontal tissue injury; STI, Soft tissue injury.

^a In one patient both maxillary and mandibular teeth were traumatized.

^b In two patients both maxillary and mandibular teeth were traumatized.

When all age groups were evaluated together, no statistically significant seasonal variation was found. The majority of patients (n = 255, 90.1%) visited during day clinic hours (Monday through Friday, 8.30 a.m. to 5.00 p.m.). Monday (26.1%, 74/283) was the busiest day and the frequency of visits during weekends (3.2%, 9/283) was significantly lower. With regard to hospital arrival time following a TDI, 131 (46.3%) patients sought treatment after more than 24 h (Table 2). Accompanying soft tissue injuries (laceration, abrasion, etc.) were present in 44 (74.6%) of the 59 patients who were seen at the hospital within 3 h following the TDI.

TABLE 2. Interval between dental trauma and arrival at hospital

Hospital Arrival Time	HDTI		PTI		HDTI + PTI		(HDTI + PTI) + STI		Total	
	N	%	n	%	n	%	n	%	N	%
<60 min	4	4.3	17	6.2	4	4.7	1	2.3	17	6.0
1–2 h	16	17.0	41	15	15	17.6	12	27.3	42	14.8
3–5 h	6	6.4	20	7.3	5	5.9	3	6.8	21	7.4
6–11 h	1	1.1	9	3.3	1	1.2	1	2.3	9	3.2
12–23 h	22	23.4	62	22.6	21	24.7	11	25.0	63	22.3
>24 h	45	47.9	125	45.6	39	45.9	16	36.4	131	46.3
Total	94	100.0	274	100.0	85	100.0	44	100.0	283	100.0

Abbreviations: HDTI, Hard dental tissue injury; n, Number of patients; PTI, Periodontal tissue injury; STI: Soft tissue injury.

Figure 1 shows the distribution of TDIs regarding tooth identification number. The maxillary right central incisor (#51) accounted for 188 (35.1%) of the injured primary teeth and was the most frequently involved tooth. Of 536 primary teeth, 111 were involved in hard dental tissue injuries and 450 in periodontal tissue injuries. In 30% (85/283) of the patients, both periodontal and hard dental tissue injuries were present. The distribution of hard dental tissue and periodontal tissue injuries is shown in Figure 2. The primary dentition was dominated by periodontal tissue injuries (97.2%–521/536) rather than injuries to the hard dental tissues (22.6%–121/536) in this series. The most common type of fracture injury to the primary teeth was “Enamel Fracture”, whereas the most frequently recorded periodontal tissue injury was “Subluxation”.

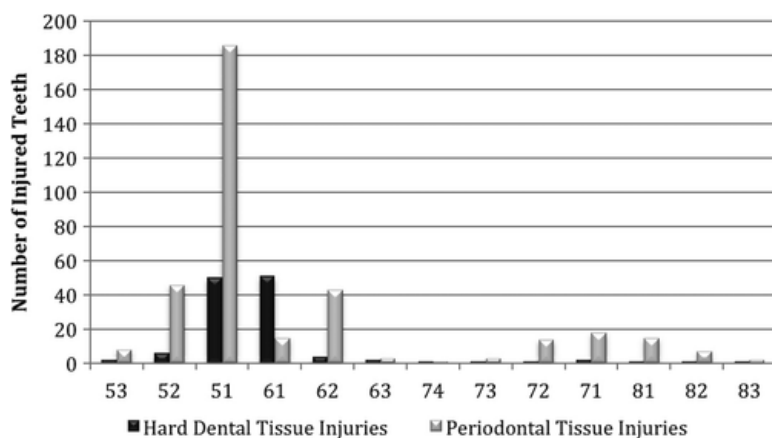


FIGURE 1 Distribution of dental trauma according to the tooth identification number

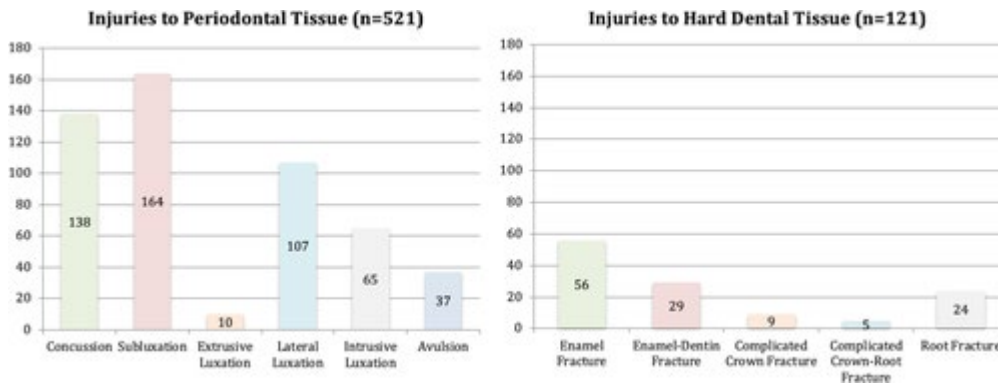


FIGURE 2 Distribution of traumatic dental injuries in this study

Table 3 shows the distribution of patients with hard dental/periodontal tissue injuries, according to the number of traumatized teeth. Among 177 patients, who experienced supporting bone and/or soft tissue injuries, 67.2% (n = 119) were found to have multiple traumatized teeth. [Colour figure can be viewed at wileyonlinelibrary.com]

TABLE 3. Number of traumatized teeth per patient with different types of injuries

Type of Injury	HDTI		PTI		HDTI + PTI		(HDTI + PTI) +STI	
N° Traumatized Teeth per Patient	N	%	n	%	n	%	n	%
1	69	24.4	107	37.8	31	11.0	14	4.9
2	22	7.8	116	41.0	42	14.8	21	7.4
3 and more	3	1.1	51	18.0	12	4.2	9	3.2
Total (N = 283)	94	33.2	274	96.8	85	30.0	44	15.5

Abbreviations: HDTI, Hard dental tissue injury; n, Number of patients; PTI, Periodontal tissue injury; STI: Soft tissue injury.

The distribution of hard dental and periodontal tissue injuries according to the cause of trauma is presented in Table 4. The most common cause of primary teeth injury was “fall accidents” (82%). This was followed by “collide with another person” (6.4%) and “hit by an object” (4.9%). The most common diagnoses for children who experienced falls were “enamel fracture” (34/232) and “enamel-dentin fracture” (21/232) as hard dental tissue injuries, while “subluxation” (85/232) and “concussion” (68/232) were the most common periodontal tissue injuries. In 81.3% (143/176) of patients with soft tissue injuries, the cause of TDI was “fall accidents”.

TABLE 4. The causes of the traumatic dental injuries in this study

		Bike accident		Collide with another person		Fall accident		Hit by an object		Other (Assault, Sports injury, etc.)	
		n	%	n	%	n	%	n	%	n	%
Hard Dental Tissue Injuries	Enamel Fracture	0	0.0	1	5.6	34	14.7	5	35.7	3	33.3
	Enamel-Dentin Fracture	0	0.0	0	0.0	21	9.1	3	21.4	1	11.1
	Complicated Crown Fracture	0	0.0	0	0.0	9	3.9	0	0.0	0	0.0
	Complicated Crown-Root Fracture	0	0.0	0	0.0	5	2.2	0	0.0	0	0.0
	Root Fracture	0	0.0	3	16.7	15	6.5	1	7.1	2	22.2
Periodontal Tissue Injuries	Concussion	4	40.0	5	27.8	68	29.3	7	50.0	4	44.4
	Subluxation	7	70.0	7	38.9	85	36.6	2	14.3	3	33.3
	Extrusive Luxation	0	0.0	0	0.0	7	3.0	1	7.1	0	0.0
	Lateral Luxation	1	10.0	5	27.8	67	28.9	6	42.9	2	22.2
	Intrusive Luxation	0	0.0	0	0.0	41	17.7	1	7.1	1	11.1
	Avulsion	4	40.0	1	5.6	22	9.5	0	0.0	2	22.2
Total (N = 283 patients)		10 ^a	3.5	18 ^a	6.4	232 ^a	82.0	14 ^a	4.9	9 ^a	3.2

^a Number of patients according to the cause of trauma.

In 176 patients (62.2%), 331 specific soft tissue injuries were diagnosed. Table 5 shows the location and type of soft tissue injuries. “Laceration” was present in 34.4% (99/283) of the patients and it was the most accompanied soft tissue injury. This was followed by abrasion (27.9%), swelling (27.6%), contusion (11.7%) and tissue avulsion (0%). In these patients, the most recorded type of periodontal tissue injuries was subluxation (66/176) and lateral luxation (61/176). Soft tissue injuries were observed more frequently with periodontal tissue injuries compared to hard dental tissue injuries. Here, it should be mentioned that “swelling” is a sign and not a type of injury. However, this was the only available form of registration in the electronic database used. Hence, it was recorded as a soft tissue injury, although not being part of the Andreasen’s soft tissue injury classification.¹⁰

TABLE 5. Location and type of soft tissue injuries

	Laceration (34.4%)		Swelling (26.6%)		Abrasion (28.4%)		Contusion (10.6%)	
	n	%	N	%	n	%	N	%
Chin	3	2.6	1	1.1	12	12.8	2	5.7
Gingiva	56	49.1	13	14.8	19	20.2	14	40.0
Labial Frenulum	6	5.3	0	0.0	3	3.2	0	0.0
Labial Mucosa	27	23.7	6	6.8	20	21.3	6	17.1
Lip	20	17.5	58	65.9	25	26.6	4	11.4
Nasal	1	0.9	3	3.4	5	5.3	2	5.7
Forehead	1	0.9	1	1.1	3	3.2	2	5.7
Other (Tongue, cheek, forehead, periorbital, etc.)	1	0.9	6	6.8	7	7.4	5	14.3
Total (N = 331)	114	100.0	88	100.0	94	100.0	35	100.0

Multiple locations may be affected in a patient.

Abbreviations: n, Number of patients; N, Total number of injured locations.

When the head and neck region was evaluated, a fractured alveolar segment was recorded in 10 of 13 patients, and fractures of other facial bones (maxilla = 1, maxilla and nasal bone = 1, skull = 1) were recorded in three patients. In all of these patients, more than one hard dental tissue injury and in seven of 13 patients more than one periodontal tissue injury was recorded. Medical co-morbidities following TDI in the primary dentition, such as loss of consciousness, spinal cord injury, brain concussion, headache, fracture outside the craniofacial area, and intensive care unit requirement were assessed. Only two of the 283 patients had concussion and headache, and one had a fracture outside the craniofacial area.

In this study, 53.4% (n = 151) of the patients were examined only and no treatment was performed, while 16.6% (n = 47) were examined with medication prescribed (Table 6). In patients who had dental treatment with or without medication (n = 85), extraction (77.6%) was the most common treatment. Of the 536 traumatized primary teeth, 114 (21.3%) were extracted. Among 10 patients with segmental alveolar fractures, five were treated with extraction and five were examined only. None of the segmental alveolar fractures were repositioned or splinted. The distribution of the number of extracted teeth regarding the type of trauma is noted in Table 7.

TABLE 6. Distribution of the treatment modalities

Treatment Modalities	n	%
Examination ^a	198	70.0
Dental treatment ^b	85	30.0

Extraction	66/85 ^c		
Restoration	16/85		
Reposition	3/85 ^c		
Reposition + Splint	1/85		
Total		283	100.0

Abbreviation: n, Number of patients.

^a Examination with medication n = 47 (16,6%)

^b Dental treatment with medication n = 23 (8,1%)

^c In one patient both extraction and reposition were performed for different teeth.

TABLE 7. Number of extracted teeth according to the type of trauma

Hard Dental Tissue Injuries									
Enamel Fracture		Enamel-Dentin Fracture		Complicated Crown Fracture		Complicated Crown-Root Fracture		Root Fracture	
n = 56		n = 29		n = 9		n = 5		n = 24	
N	%	N	%	n	%	n	%	n	%
2	3.6	1	3.4	7	77.8	4	80.0	11	45.8
Periodontal Tissue Injuries									
Concussion		Subluxation		Extrusion		Lateral Luxation		Intrusion	
n = 138		n = 164		n = 10		n = 107		n = 65	
N	%	n	%	n	%	n	%	n	%
13	9.4	17	10.4	9	90.0	37	34.6	13	20.0

Abbreviation: n, Number of teeth

Radiographs were taken for 187 (66.1%) patients and periapical radiographs were the most frequent type (86.6%, 162/187), followed by occlusal radiographs (7.5%, 14/187), multiple radiographs (4.8%, 9/187) and lateral cephalometric images (1.1%, 2/187). Most of the patients (93.8%, 90/96) without radiographic evaluation were 3 years old or younger.

Total survival time of the traumatized primary teeth was also evaluated. The results revealed that for 67.7% of the traumatized teeth, the survival time following TDI was unknown due to non-attendance at follow-ups (85.4%, 310/363) or on-going follow-up appointments (14.6%, 53/363). Assessment of survival time was not applicable for 129 (24.1%) teeth due to extraction after trauma or avulsion of the tooth. Only 15 (2.8%) teeth were followed up until spontaneous exfoliation time and for 29 (5.4%) teeth, the survival time was known as these teeth were extracted due to symptoms during follow-up examinations.

Outcomes indicating the prognosis of traumatized teeth such as being asymptomatic, repair of fractured segments, resorption of the remaining apical fragment, pulp canal obliteration, crown discoloration, spontaneous exfoliation, pulp necrosis with infection, pathological root resorption, apical periodontitis and widened periodontal ligament spaces were also collected. For 125 (16.7%) traumatized primary teeth, one or more of these findings were recorded during follow-up visits. Among these teeth, the most reported outcomes

were being asymptomatic until the last follow-up visit (42.4%, 53/125) or crown discoloration (31.2%, 39/125) as examples of clinical success. Pulp necrosis with infection (18.4%, 23/125) was the most common complication.

Timing of the first post-trauma follow-up visit is shown in Table 8. A majority (55.1%) of patients who were seen at the hospital due to primary teeth injuries did not attend the first follow-up appointment. Among 34 patients who attended a follow-up visit within two weeks, 23 (67.6%) had multiple teeth injuries. Lateral luxation (n = 16, 47.1%) was the most frequent diagnosis and 26 (76.5%) had concomitant soft tissue injuries. The most scheduled follow-up time by the dentists was “four weeks later” (56.5%) and this was followed by “two weeks later” (14.5%).

TABLE 8. Timing of the first post-trauma follow-up appointment

First Follow-up Appointment (N = 283)									
No follow-up		<2 weeks		3 weeks		4 weeks		>4 weeks	
N	%	n	%	n	%	n	%	n	%
156	55.1	34	12.0	15	5.3	61	21.6	17	6.9

Abbreviation: n, Number of patients.

4 DISCUSSION

In the literature, few reports address TDIs to primary teeth.^{4, 5} However, the overall incidence has ranged from 30% to 62%.¹¹⁻¹³ As most of the studies have focused on epidemiology, studies with adequate sample size are needed to identify the most effective treatment, prognosis or risk factors for the primary dentition.^{5, 14} Accordingly, this study contributes to the literature by evaluating patients who presented to an urban children's hospital following primary teeth trauma.

The findings of the current study are consistent with previous reports regarding patient demographics, injury type (periodontal tissue injury), cause of dental trauma (falls) and traumatized primary teeth (maxillary central incisors).^{12, 15-19} In all age groups, maxillary primary teeth were more frequently traumatized than mandibular teeth. Furthermore, concomitant injuries (Hard dental tissue injuries + Periodontal tissue injuries or Hard dental tissue injuries +Periodontal tissue injuries + Soft tissue injuries) were distinctively less than those registered alone. In many studies, gender is a noteworthy factor demonstrating male predominance of dental trauma in pediatric population due to more risky behavior.^{15, 17, 19, 20} It is also well known that more flexible alveolar bone around primary teeth results in periodontal tissue injuries rather than hard dental tissue injuries.^{21, 22} In several studies, a seasonal pattern of increased TDIs experienced by older children in summer has been reported.^{23, 24} This has been attributed to the higher frequency of sports-related dental trauma during summer in older children due to bicycle or pool accidents in which the permanent teeth were most frequently injured.²⁰ However, no such pattern was found in the present study. The finding may be explained by the lower mean age of the patients (3 ± 1.72 years) and their non-engagement in any sports. Additionally, indoor fall accidents are the main source of TDIs in toddlers whose motor coordination is still developing.^{16, 25} Hence, close parental supervision and making homes safer are recommended to help prevent traumatic injuries.^{16, 18, 19, 25}

Most patients (90.1%) received care at the dental clinic during clinic hours. Although some authors have reported that TDIs are a common presentation to the emergency department,^{16, 19, 26} in the children's hospital where this study was conducted, the presence of a pediatric dental clinic and on-call resident/faculty after clinic hours may have reduced the presentation to both emergency department (ED) and urgent care (UC). This finding may also suggest that parents are less concerned about primary dentition injuries which could be a topic of future research.

It was asserted that early care-seeking for TDIs would be indicative of more complex dental trauma accompanied by soft tissue injury.^{19, 27} Collinear findings in this study indicated that 74.6% of the patients who were seen within 3 h had accompanying soft tissue injuries. Still a considerable time lapse (>24 h) was present prior to hospital arrival for almost half of the patients. Other reports have suggested that the most common reasons for late referral are underestimation of primary teeth trauma by the parents, and prolonged transit time or parental unavailability.^{18, 28}

Sae-Lim et al.²⁹ reported that 45% of dental TDIs had concomitant soft tissue injuries and usually multiple teeth were involved. In the current study, 67.2% of the patients with soft and/or hard tissue injuries had multiple traumatized teeth and lacerations (especially gingival) were the most common soft tissue diagnosis, which is similar to previous reports.^{19, 30} On the other hand, the incidence of facial fractures in children is low but has been shown to be higher for mandibular fractures in adolescence.^{29, 31, 32} The occurrence of facial fractures in only three patients and the low mean age in this study confirm the current available literature.

Medical co-morbidities following TDIs in the primary dentition have not previously been described. When young children present to the ED with severe trauma, dental evaluation and consultation with the on-call pediatric dentist may be deferred by the triage team. It has been reported that many dental trauma cases attending an ED were not seen by pediatric dentists²⁷ and only a limited number of ED physicians feel adequate to manage common dental injuries.^{17, 33} This study suggests that when TDI is the presenting problem, accompanying systemic injury is rare.

Unfortunately, no consensus about the optimal treatment of traumatized primary teeth exists, and treatment depends on variables such as the cooperation of the child, the exfoliation timing of the tooth, or the occlusion.⁹ Also, most periodontal tissue injuries in the primary dentition can heal naturally without the requirement for tooth extraction.^{22, 34, 35} The finding that 70% of the patients were examined only or prescribed medication in this study was compatible with the literature.^{20, 22} This could also be attributed to very young age of the patients (peak age =2 years) in the present study. The types of traumatic injury with the highest rate of tooth extraction were extrusion, complicated crown-root fracture and complicated crown fracture.

In the present study, the survival was not known for 67.7% of the traumatized teeth as a consequence of non-attendance at follow-up appointments. However, current guidelines on TDIs in the primary dentition recommend clinical and/or radiographic monitoring after at least one year and each subsequent year until the eruption of the permanent successor depending on the type of trauma.⁹ Unlike the current study where pulp necrosis with infection was the most common complication, Cho et al.³⁶ reported that pathological root resorption (31.1%) and tooth loss (25.0%) were the most encountered complications after primary teeth injury.

The importance of follow-up must be emphasized when evaluating the potential risk of damage to the permanent successor following a primary tooth injury.^{6, 8} The present study is the first to evaluate the compliance with follow-up visits after TDIs in the primary dentition. Hence, a direct comparison of results could not be made. For the permanent dentition, Gustafson et al.³⁷ reported that patients with avulsion, luxation or intrusion injuries attended fewer than three follow-up visits (on average) at the same dental hospital. However, at least five visits during the first year have been recommended by the International Association of Dental Traumatology.³⁸ In the present study, more than half of the patients did not even attend the first follow-up appointment after four weeks. Furthermore, it might be assumed that concomitant injuries may result in scheduling the first follow-up appointment earlier (<2 weeks).

Limitations of the study include record-keeping by multiple reporters and variable data for on-going follow-up of some patients due to archiving primary teeth trauma data for the past three years only. However, all reporters

were trained in data entry for dental trauma and a software program was used to ensure standardized recording.

Based on the results of the present study, the following conclusions can be made:

1. TDIs in primary dentition most frequently affected the periodontal tissues.
2. Medical co-morbidities were rarely seen with TDIs in the primary dentition.
3. No seasonal effect existed and fall injury was the main cause of TDIs to primary teeth.
4. Examination and extraction were the most common protocols performed following primary teeth trauma.
5. The follow-up appointments were poorly attended after a TDI to a primary tooth.

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AUTHOR CONTRIBUTION

The manuscript has been read and approved by all of the authors, and the requirements for authorship have been met. Each author believe that the manuscript represents honest work. Criteria for inclusion in the authors'/ contributors' list. Concept and design of study or acquisition of data or analysis and interpretation of data. Drafting the article or revising it critically for important intellectual content. Final approval of the version to be published.

CONFLICT OF INTEREST

The authors declare that they do not have any conflict of interest.

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