








Factors Associated with Complex Treatments for Injured Deciduous Teeth: A Retrospective Study

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ABSTRACT

Objective: To investigate the occurrence and factors associated with complex treatments (endodontic treatment or extraction) for injured deciduous teeth. **Material and Methods:** A retrospective study was carried out with the dental records of 505 children aged one to seven years old with traumatic dental injuries treated at the Clinic for Traumatic Dental Injuries in Primary Dentition at the Federal University of Minas Gerais, Belo Horizonte, Brazil. Sociodemographic characteristics, information about the dental injury, and the types of treatment performed were collected from the patient's records. Descriptive and Poisson regression analyses were performed ($p < 0.05$; 95% CI). **Results:** Complex treatments were performed in 31.7% of children with traumatic dental injuries to primary teeth. Of these children, 4.8% underwent pulpectomy, and 26.9% underwent extraction. Factors associated with the occurrence of complex treatments were the child's age ≥ 3 years at the time of the injury (RR=1.61; 95% CI: 1.24-2.09; $p=0.001$), family income less than twice the minimum monthly salary (RR= 1.29; 95% CI: 1.01-1.66; $p= 0.041$), coronary fractures with pulp involvement (RR=2.82; 95% CI: 1.98-4.02; $p < 0.001$) and not seeking immediate care (RR= 1.29; 95% CI: 1.01-1.65; $p=0.048$). **Conclusion:** The occurrence of complex treatment after traumatic dental injuries in the primary dentition was approximately 30% and was associated with the child's older age, lower family income, type of injury, and failure to seek immediate treatment.

Keywords: Tooth Injuries; Tooth, Deciduous; Child; Endodontics; Tooth Extraction.

■ Introduction

Traumatic dental injuries to the deciduous dentition are common in childhood. They are considered a public health problem due to the high prevalence and impact on the quality of life of both the affected children and their families [1]. Epidemiological studies report that the prevalence of such injuries to the deciduous dentition is around 24.2% [2], although this figure can vary considerably depending on the population studied and the diagnostic methods.

Dental injuries can have immediate consequences for a primary tooth due to the direct mechanical action caused by tooth displacement and long-term consequences such as pulp necrosis, infection with periapical inflammation, pathological root resorption, and tooth loss [3-7]. Many complications require complex treatments, such as endodontic treatment and extraction. The literature indicates that the severity of the sequelae is often related to the need for complex interventions. For example, more severe injuries increase the likelihood of pulp necrosis and infection, frequently requiring endodontic treatment to preserve the affected tooth [8,9]. Similarly, cases of pathological root resorption or extensive periapical infection may result in the need for extraction of the affected tooth [8-10].

Knowledge of factors that lead to complex treatments is of extreme importance to guiding conduct in situations of injuries to deciduous teeth and underscores the need for counseling with regard to prevention and immediate care after an injury to diminish the need for such types of treatment. Therefore, the present retrospective study aimed to investigate the occurrence and factors associated with complex treatments (endodontic treatment or extraction) for injured deciduous teeth.

The hypothesis is that the initial severity of the trauma and the search for immediate treatment influence the need for complex treatments for children.

■ Material and Methods

Ethical Aspects

This study received approval from the Human Research Ethics Committee of the Federal University of Minas Gerais (Opinion No. 3.386.630). The legal guardians of the participants eligible for the study signed a statement of informed consent.

Study Setting, Design, and Population

The present retrospective study consisted of the analysis of the dental records of children who suffered an injury to the deciduous dentition and sought care between 2007 and 2019 at the Deciduous Dentition Traumatic Dental Injury Clinic of the Federal University of Minas Gerais in the city of Belo Horizonte, Brazil. This clinic is considered a reference center for care in the field of dental injuries to the deciduous dentition in the region. The children are followed up until the exfoliation of the injured deciduous tooth and eruption of the permanent tooth.

Records were analyzed of children one to seven years of age who had an injured deciduous tooth and at least one year of follow-up at the clinic. Children with incomplete records, those in whom the injured tooth suffered avulsion, and those with systemic diseases or syndromes that could affect the immune response were excluded.

Work Team, Training, and Pilot Study

The work team was formed by researchers who underwent prior training regarding the criteria and care in analyzing patient records. Two researchers selected and analyzed dental records and tabulated the data. A pilot study was conducted with 30 records to determine the applicability of the data collection process. As no method changes were deemed necessary, these 30 records were included in the main study.

Data Collection

The following data were collected from the dental records:

- Variables related to the child and family: Sex and age of the child (older or younger than three years of age), nonnutritive sucking habit (presence or absence), oral hygiene (satisfactory or unsatisfactory), monthly family income, and mother's schooling. Family income was calculated considering the monthly minimum wage at the time of completing the forms. It was categorized based on the median (up to two times or more than two times the monthly minimum wage). Mother's schooling was categorized as basic/fundamental (0 to nine years of study), high school (10 to 12 years of study), or higher education (more than 13 years of study), following the division proposed by the Brazilian Ministry of Education.
- Variables related to the dental injury: Diagnosis of the injury, whether the repeated injury had occurred (yes or no), the immediate search for care within two hours of the injury (yes or no), how the injury occurred (fall, strike, or impact), and whether a change in the color of the tooth crown occurred during follow-up (yes or no).

The classification of dental injuries was based on the criteria proposed by Andreasen et al. [10]. For statistical purposes, these diagnoses were grouped as follows: luxation without displacement (concussion and subluxation), luxation with displacement (lateral luxation, intrusive luxation, and extrusive luxation), fractures without pulp involvement (enamel fracture, enamel/dentin fracture, crown-root fracture) and fractures with pulp involvement (enamel/dentin fracture, crown-root fracture, root fracture). Furthermore, these injuries were categorized into "hard tissue" and "supporting tissue". Hard tissue injuries were considered: enamel fracture, enamel/dentin fracture without pulp exposure, enamel/dentin fracture with pulp exposure, crown-root fracture without pulp exposure, crown-root fracture with pulp exposure, and root fracture. Supporting tissue lesions were classified as concussion, subluxation, lateral luxation, intrusive luxation, and extrusive luxation".

The administration of complex treatment (endodontic treatment or extraction) for injured teeth during the follow-up appointments was also investigated. This was considered the dependent variable of the study and was dichotomized as yes or no.

Statistical Analysis

The data were tabulated and analyzed with the Statistical Package for the Social Sciences, version 25.0 (SPSS Inc., Chicago, IL, USA). Descriptive data analysis was performed to determine the distribution of the dependent variable (administration of complex treatments) in the categories of the independent variables.

Poisson regression analysis with robust variance was used to determine associations between the administration of complex treatment and each independent variable. Variables with a p-value < 0.20 in the bivariate model and those judged by the team as critical confounding factors concerning the outcome were incorporated into the multivariate final model. Relative risk (RR) and 95% confidence intervals (CI) were calculated. The level of statistical significance established for the analyses was 5%.

■ Results

A total of 732 dental records were analyzed, 227 of which were excluded due to incomplete records, the diagnosis of dental avulsion, or the occurrence of more than one type of dental injury in the child. Thus, the final sample was composed of 505 dental records.

The distributions of the variables related to the child and dental injury are displayed in Table 1. Among the children, 55.2% were male, and the mean age was 35.6 ± 16.3 months. Maxillary central incisors were the most affected teeth (83.6%), and the most common type of injury was enamel fracture (22.2%), followed by intrusive luxation (16.2%). A total of 31.7% (n=160) of the children were submitted to complex treatment for the injured tooth; 4.8% (n=24) were submitted to pulpectomy, and 26.9% (n=136) were submitted to extraction.

A more significant occurrence of complex treatments was found in children aged three years or older (39.8%), those who were from families with an income lower than two times the monthly minimum wage (37.3%), and those who did not seek immediate treatment after the injury (34.1%). Children presenting fractures with pulp involvement also had a greater occurrence of complex treatments (74.5%).

Table 1. Descriptive analysis of sample according to variables related to child and dental injury.

Variables	Occurrence of Complex Treatments		Total N (%)
	No N (%)	Yes N (%)	
Variables related to child and family			
Sex			
Female	161 (71.2)	65 (28.8)	226 (44.8)
Male	184 (46.7)	95 (34.1)	279 (55.2)
Age at the Time of Injury			
< 3 years	203 (75.5)	66 (24.5)	269 (53.3)
≥ 3 years	142 (60.2)	94 (39.8)	236 (46.7)
Family Income			
≥ 2 x monthly minimum wage	185 (74.0)	65 (26.0)	250 (49.5)
< 2 x monthly minimum wage	160 (62.7)	95 (37.3)	255 (50.5)
Mother's Schooling			
Higher education	110 (75.3)	36 (24.7)	146 (28.9)
High school	190 (65.1)	102 (34.9)	292 (57.8)
Basic/fundamental	45 (67.2)	22 (32.8)	67 (13.3)
Oral Hygiene			
Satisfactory	218 (70.6)	91 (29.4)	309 (61.2)
Unsatisfactory	127 (64.8)	69 (35.2)	196 (38.8)
Nonnutritive Sucking Habit			
Absent	213 (65.3)	113 (34.7)	326 (64.6)
Present	132 (73.7)	47 (26.3)	179 (35.4)
Variables related to dental injury			
Repetition Injury			
No	289 (68.3)	134 (31.7)	423 (83.8)
Yes	56 (68.3)	26 (31.7)	82 (16.2)
Alteration of Crown Color			
No	280 (70.9)	115 (29.1)	395 (78.2)
Yes	65 (59.1)	45 (40.9)	110 (21.8)
Type of Dental Injury			
Luxation without displacement	69 (72.6)	26 (27.4)	95 (18.8)
Luxation with displacement	136 (70.1)	58 (29.9)	194 (38.4)
Fracture without pulp involvement	127 (77.0)	38 (23.0)	165 (32.7)
Fracture with pulp involvement	13 (25.5)	38 (74.5)	51 (10.1)
Injury to Affected Tissue			
Hard tissue	140 (64.8)	76 (35.2)	216 (42.8)
Supporting tissue	205 (70.9)	84 (29.1)	289 (57.2)
Diagnosis of Dental Injury			

Concussion	32 (100.0)	0 (0.0)	32 (6.3)
Subluxation	37 (64.6)	26 (41.3)	63 (12.5)
Lateral luxation	50 (62.5)	30 (37.5)	80 (15.8)
Intrusive luxation	61 (74.4)	21 (25.6)	82 (16.2)
Extrusive luxation	25 (78.1)	7 (21.9)	32 (6.3)
Enamel fracture	91 (81.3)	21 (18.8)	112 (22.2)
Dentin fracture	35 (74.5)	12 (25.5)	47 (9.3)
Enamel/dentin fracture with pulp exposure	5 (35.7)	9 (64.3)	14 (2.8)
Crown-root fracture without pulp exposure	1 (16.7)	5 (83.3)	6 (1.2)
Crown-root fracture with pulp exposure	3 (17.6)	14 (82.4)	17 (3.4)
Root fracture	5 (25.0)	15 (75.0)	20 (4.0)
Immediate Care			
Yes	208 (70.0)	89 (30.0)	297 (58.8)
No	137 (65.9)	71 (34.1)	208 (41.2)
How Injury Occurred?			
Fall	283 (69.0)	127 (31.0)	410 (81.2)
Strike	14 (82.4)	3 (17.6)	17 (3.4)
Impact	48 (61.5)	30 (38.5)	78 (15.4)

Table 2 displays the results of the adjusted Poisson regression analysis. The following variables were associated with the occurrence of complex treatments: child's age equal to or older than three years at the time of the injury (RR=1.61; 95% CI:1.24-2.09; p=0.001), family income less than two times the monthly minimum wage (RR=1.29; 95% CI:1.01-1.66; p=0.041), crown fractures with pulp involvement (RR=2.82; 95% CI:1.98-4.02; p<0.001) and failure to seek immediate care (RR=1.29; 95% CI:1.01-1.65; p=0.048).

Table 2. Poisson regression for associations between occurrence of complex treatment and independent variables.

Variables	Unadjusted RR (95% CI)	p-value	Adjusted RR (95% CI)	p-value
Sex				
Female	1			
Male	0.84 (0.65–1.10)	0.207		NS
Age at the Time of Injury				
< 3 years	1		1	
≥ 3 years	1.62 (1.25–2.11)	<0.001	1.61 (1.24–2.09)	<0.001
Family Income				
≥ 2 x monthly minimum wage	1			
< 2 x monthly minimum wage	1.43 (1.10–1.86)	0.007	1.29 (1.01–1.66)	0.041
Mother's Schooling				
Higher education	1			
High school	1.42 (1.02–1.96)	0.035		
Basic/fundamental	1.33 (0.85–2.08)	0.207		NS
Oral Hygiene				
Satisfactory	1			
Unsatisfactory	1.19 (0.92–1.54)	0.173		NS
Nonnutritive Sucking Habit				
Absent	1			
Present	0.76 (0.57–1.01)	0.058		NS
Repetition Injury				
No	1			
Yes	1.01 (0.70–1.42)	0.996		NS
Alteration of Crown Color				
No	1			
Yes	1.40 (1.07–1.84)	0.014		NS
Type of Dental Injury				
Luxation without displacement	1		1	
Luxation with displacement	1.09 (0.74–1.62)	0.659	1.27 (0.87–1.85)	0.216
Fracture without pulp involvement	0.84 (0.55–1.29)	0.432	0.96 (0.63–1.45)	0.813

Fracture with pulp involvement	2.72 (1.89–3.92)	<0.001	2.82 (1.98–4.02)	<0.001
Immediate Care				
Yes	1		1	
No	1.14 (0.88–1.47)	0.320	1.29 (1.01–1.65)	0.048
How Injury Occurred?				
Fall	1			
Strike	0.57 (0.20–1.61)	0.288		NS
Impact	1.24 (0.91–1.70)	0.179		NS

NS: Not significant.

■ Discussion

The present study investigated factors associated with complex treatments (endodontic treatment and extraction) for injured deciduous teeth. The findings demonstrated that the older age of the child, lower family income, failure to seek immediate care, and the occurrence of fractures with pulp involvement were associated with a more significant occurrence of these types of treatment.

The occurrence of extraction and endodontic treatment was 26.9% and 4.8%, respectively. The literature reports that the frequency of complex treatments for injured deciduous teeth ranges from 6.3% to 39.8% for extractions and 2.3% to 15.7% for endodontic treatment [11–17], similar to the rates found in the present study. This variability occurs due to the methodological differences of each study, such as the forms of classification of dental injuries, the age range of the participants, and the setting in which the studies were conducted.

In the present study, fractures with pulp involvement, also called complicated fractures, resulted in a higher occurrence of complex treatments. Indeed, the type of injury influences the degree of sequelae in the patient [18]. Previous studies demonstrated that complicated fractures have a greater risk of bacterial contamination with progression to pulp necrosis [7,19], resulting in the indication for pulpectomy or extraction [13]. Another relevant factor in such cases is seeking immediate treatment, as exposure of the pulp tissue to infectious agents for a longer time results in greater contamination of the pulp and adjacent supporting tissues.

The present findings demonstrated that complex treatments were higher among individuals who failed to seek immediate treatment for dental injury. The literature also shows a more favorable prognosis when dental care is performed as soon as possible in children with an injury to a deciduous tooth [20]. Besides the negative impact on the dental pulp that can occur at the crown level in cases of fracture, the intensity of the injury can also lead to the rupture of the neurovascular bundle, and the exposed tissues become more vulnerable to bacterial contamination [21]. Therefore, the prognosis is poorer the later that treatment is sought due to the greater exposure to bacterial colonization, and the choice of complex treatments for the injured tooth is often necessary [8,22].

Children three years or older were associated with a greater incidence of complex treatments for injured teeth. The literature shows that the level of aggravation resulting from an injury is related to the degree of root maturity of the deciduous tooth [7]. Younger children have a more excellent vascular supply and greater resilience of the alveolar bone. In comparison, the aging of the pulp tissue and physiological resorption in older children influence the degeneration of the pulp tissue and the vulnerability to pulp necrosis [18], which could explain our findings. Furthermore, younger children have more severe sequelae of dental injuries due to incomplete development of dental tissues and greater potential for structural damage, which results in a greater need for complex treatments to manage these complications [7,18].

The occurrence of complex treatments was more significant among children from low-income families. Failure to seek immediate treatment after a dental injury may be related to an unfavorable socioeconomic status [14,23,24]. This vulnerability may limit access to health information and dental services [14,24,25], which could

result in the development or progression of injuries. The search among such parents for dental care often only occurs when the child experiences pain or dental edema [25,26], when the prognosis is unfavorable, requiring complex treatments [26].

As the present study had a convenience sample of patients treated at a dental clinic, the results should be considered cautiously. Another limitation was the lack of calibrated examiners for the clinical assessments. Different undergraduate students performed oral clinical examinations throughout the semesters of the functioning of the Deciduous Dentition Dental Injury Clinic of the Federal University of Minas Gerais. However, prior training was performed, and discussions were held with the students regarding the criteria for the clinical assessments, along with the verification of the examinations on the part of experienced, calibrated professors, which contributes to precise clinical diagnoses.

Another limitation regards the loss of data due to incomplete questionnaires, which occurred mainly due to the reports of parents who did not know or could not remember information related to the children's dental injuries. Despite these common limitations in retrospective studies, this design is of considerable relevance for investigations addressing dental injuries, as these conditions are often not identified in population-based epidemiological studies when there are no visible sequelae. Thus, retrospective studies of patients treated at dental injury reference centers offer essential information for clinical situations often not found in other studies.








The methodological heterogeneity of studies in the literature limits comparisons to our findings. Despite the lack of standardization in many respects, the criteria for diagnosing injuries to deciduous teeth in our and most studies in the field is the classification proposed by Andreasen et al. [10], which is also adopted by the World Health Organization. Future studies with different populations are encouraged to better understand this issue, especially addressing each type of dental injury individually and the prevalence of each treatment specifically.

■ Conclusion

The present study's findings enable a better understanding of factors that affect the prognosis of an injured deciduous tooth and factors that possibly lead to complex treatments, assisting in guiding professional efforts and public policies directed at caring for child health. Public policies are needed to orient parents/guardians regarding preventing and controlling injuries to deciduous teeth and the importance of seeking immediate care after such injuries, which could contribute to a lower need for complex treatments in deciduous dentition.

In the present study, complex treatments for injured deciduous teeth occurred in approximately 30%. The factors associated with the more significant occurrence of such treatments were a child's age of three years or older, a family income less than two times the monthly minimum wage, the occurrence of fractures with pulp exposure, and failure to seek immediate care.

■ Authors' Contributions

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All authors declare that they contributed to a critical review of intellectual content and approval of the final version to be published.

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■ Conflict of Interest

The authors declare no conflicts of interest.

■ Data Availability

The data used to support the findings of this study can be made available upon request to the corresponding author.

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