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Dental trauma and itssequelae in deciduous and permanent teeth - Longitudinal study

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ABSTRACT. Objective: This study evaluated the prevalence, clinical management and sequelae in deciduous teeth involved and permanent successors in 150 children (256 deciduous teeth. Of these, 63.3% were male, 24-35 months of age at the time of the trauma (37.9%) and the falls (78.1%) represented the major etiological factor. In relation to the type of injury, 24.6% was enamel fracture; 62.5% showed support tissue injury (lateral luxation, 22.3%). In the first and second assessments (T1 and T2), the average follow-up time was 14.5 and 26 months (256 and 131 teeth).We diagnosed clinical and radiographic sequels including discoloration of the crown (T1-15.6; T2-13.7%), inflammatory root resorption (T1-7.0; T2-8.4%); and in permanent successors, enamel hypoplasia (T1-1.2; T2-2.3%), eruption disturbances (T1-2.0; T2-1.5%).The chi-square test evidenced association, in T1, between injuries to the supporting tissues and clinical ($p = 0.003$) and radiographic ($p = 0.004$) sequelae in permanent successors; and between clinical sequelae and age at the time of trauma ($p = 0.005$). In T2, radiological sequelae in deciduous teeth with injuries to the tooth and supporting tissue ($p = 0.035$); as well as clinical sequelae with elapsed time of trauma in permanent teeth ($p = 0.005$). It is concluded that the follow-up of traumatized deciduous teeth is essential to prevent sequelae.

Keywords: dental trauma; deciduous tooth; permanent dentition; child.

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Introduction

In the first years of life when children start to walk and run, they become more susceptible to traumatic injuries todeciduous teeth (Cunha, Pugliesi, & Vieira, 2001; Cardoso & Rocha 2002; Jesus, Antunes, Risso, Freire, & Maia, 2010; Coutinho & Cajazeira, 2011; Assunção, Ferelle, Iwakura, Nascimento, & Cunha, 2011). The transmission of force after a trauma on hard tissues and pulp of the tooth and on periodontal tissues can lead to sequels in the affected teeth or permanent successors (Cardoso & Rocha, 2010). The occurrence of sequelae may be associated with several factors, such as the age of the child at the time of trauma, the degree of root resorption of the injured deciduous tooth, the type and extent of the injury, and the stage of development of the permanent tooth germ (Altun, Cehreli, Güven, & Acikel, 2009; Carvalho, Jacomo, & Campos, 2010; Amorim, Estrela, & Costa, 2011; Güngör, Püşman, & Uysal, 2011; Costa et al., 2016). In the scientific literature, there is no consensus on the prevalence of traumatic lesions in the first dentition, which varies from 15 to 40% (Cunha et al., 2001; Feldens, Kramer, Vidal, Faraco Junior, & Vítolo, 2008; Jorge et al., 2009; Feldens, Borges, Vargas-Ferreira, & Kramer, 2016) according to location and age at the time of trauma. However, many of the dental injuries caused by accidents are not examined early by dentists and often go unnoticed by parents and/or guardians (Osuji, 1996).

In situations of trauma involving the deciduous dentition, the dental surgeon must be attentive to the child's anxiety, controlling pain and, whenever possible, performing the necessary techniques to preserve the affected tooth (Kramer, Onetto, Flores, Borges, & Feldens, 2016), thus avoiding functional and aesthetic disorders related to the infant patient. These factors, in turn, may interfere with the child's quality of life (Holan & Needleman, 2014; Toprak, Tuna, Seymen, & Gençay, 2014), since they cause eating disorders, affect arch integrity, and especially the development of permanent successors (Holan & Needleman, 2014). Therefore, it is essential to raise awareness among parents about the injuries that can affect deciduous teeth and permanent successors after trauma (Malmgren et al., 2012; Kramer, Onetto, Flores, Borges, & Feldens,

2016), since treatment as well as follow-up of the affected tooth through periodic clinical and radiographic examination minimizes sequelae resulting from the trauma (Cardoso & Rocha 2004; Rocha & Cardoso, 2007; Kramer, Onetto, Flores, Borges, & Feldens, 2016).Among the sequelae reported for deciduous teeth are discoloration of the crown (Carvalho et al., 2010; Qassem, Goettems, Torriani, & Pappen, 2014; Costa et al., 2016), pulp necrosis (Carvalho et al., 2010; Costa et al., 2016), pulp calcification (Santos, Cardoso, & Almeida, 2011; Qassem et al., 2014; Costa et al., 2016), inflammatory resorption (Qassem et al., 2014) and ankylosis (Cardoso & Rocha, 2004; Altun et al., 2009; Amorim et al., 2011). It is also worth noting that trauma in the deciduous dentition can affect the germ of the developing permanent tooth, since it is separated from the periapical region of the deciduous tooth by a hard tissue barrier less than 3 mm thick (Carvalho et al., 2010; Altun et al., 2009; Amorim et al., 2011; Güngör et al., 2011).The most frequently mentioned sequelae in permanent successors include enamel hypoplasia (Carvalho et al., 2010; Altun et al., 2009; Amorim et al., 2011; Güngör et al., 2011), discoloration (Christophersen, Freund, & Harild, 2005; Jácomo & Campos, 2009), deformation of the crown and/or root (Altun et al., 2009; Costa et al., 2016), root dilaceration (Altun et al., 2009), abnormal position (Altun et al., 2009; Costa et al., 2016), prolonged retention (Jácomo & Campos, 2009), eruption disturbances (Altun et al., 2009; Jácomo & Campos, 2009), among others.

In the literature, although many studies report scientific experiments in several countries and Brazilian states (Assunção, Ferelle, Iwakura, & Cunha, 2009; Jesus et al., 2010; Coutinho & Cajazeira, 2011; Bücher, Neumann, Hickel, & Kühnisch, 2013; Viegas et al., 2014; Berti, Hesse, Bonifácio, Raggio, & Bonecker, 2015; Elkarmi, Hamdan, Rajab, Abu□Ghazaleh, & Sonbol, 2015; Feldens, Borges, Vargas-Ferreira, & Kramer, 2016), there are no studies determining data on dental trauma in deciduous dentition in the northern region of the State of Paraná (PR), Brazil. In view of the above, the goal of the present study was to determine the prevalence, clinical management, and sequelae evaluation of deciduous teeth affected by trauma and permanent successors, in children attending the Dental Clinics of the State University of Maringá, State of Paraná, between 2011 and 2016. It was evaluated the association between the trauma-related variables and the age of the children at the time of trauma as well as the time elapsed from the trauma and the sequelae to the deciduous and permanent teeth.

Material and methods

The present study was submitted to the Standing Committee on Ethics in Research Involving Human Beings of the State University of Maringá, Opinion 1.144.717 (CAAE 43711315.0.0000.0104).

This longitudinal study was performed with children at the Dental Clinics of the State University of Maringá, State of Paraná, with a history of dental trauma involving deciduous teeth in the period from 2011 to 2016. The sample consisted of 150 children, who received emergency treatment at the Dental Clinics of the State University of Maringá, totaling 256 primary teeth. All the information necessary for the study, regarding the data of the child at the time of the trauma, such as gender, age, cause of trauma, teeth involved, type of injury, time elapsed for the first care and injuries already observed in the first service were collected from the chartof the patient. Those responsible for the children were advised on the importance of the follow-up of teeth with previous history of trauma, and then the patient was scheduled for post-trauma assessment.

A single dental surgeon, through clinical and radiographic examination, evaluated children at two different times: time 1 (T1) and time 2 (T2), and all data were recorded in specific records. The clinical appointments were performed at the Dental Clinics, after consent of the guardian and/parent with the signing of the Informed Consent for children.

For each patient, dental prophylaxis was performed, followed by a detailed clinical examination of the teeth involved in the trauma, by means of palpation and percussion. Periapical or occlusal radiographs were then taken, with radiographic film 02. The injuries and clinical and radiographic sequelae of the deciduous and permanent teeth were duly classified according to that proposed by Andreasen, Andreasen, and Andersson (2013) considering the following aspects: Clinical signs: absence of clinical signs; discoloration of the crown, abscess and fistula; Radiographic signs: absence of radiographic alteration, periapical lesion, inflammatory resorption, pulp calcification, ankylosis.For the analysis of clinical and radiographic sequelae in permanent teeth, the following clinical signs were considered: discoloration of the crown, hypoplastic enamel, crown dilaceration; Radiographic signs: root dilaceration, odontoma, root duplication, incomplete root development, permanent tooth malposition, eruption disturbances.

For cases diagnosed with pathological alterations in deciduous or permanent teeth, the patients were referred to the Pediatric Residency Program of the State University of Maringá, where they received the appropriate clinical treatment for the case.

Data were collected for the types of injuries of hard tissues and pulp and periodontal tissues, clinical and radiographic sequelae of deciduous teeth and their permanent successors, time elapsed post-trauma for evaluation and treatment. Quantitative data were analyzed using the software Statistical Package for the Social Sciences (SPSS for Windows, version 15.0, SPSS® Inc, Chicago, III), obtaining the relative frequency (%) of the variables studied. In order to check for association between the variables related to the trauma, data were analyzed according to the age of the children at the time of the trauma, as well as the time elapsed from the trauma with the sequelae for the deciduous and permanent teeth, using the Chi-Square test ($p < 0.05$).

Results

We evaluated 150 patients with a history of dental trauma in deciduous teeth, totaling 256 traumatized teeth. The age of the children at the time of dental trauma ranged from 1 to 6 years, the most prevalent age was 24-35 months (37.9%), male gender (63.3%); the main etiological factor was the fall from own height (78.1%) and the upper dental arch was the most affected (97.3%). The deciduous upper central incisors were the most affected teeth, tooth 61 (43.4%) and tooth 51 (41.4%); the left side was more affected (51.9%) than the right side (48.1%). For 7.8% children, there was a previous history of dental trauma.

During the clinical examination, at the time of the trauma, there was no injury to the hard dental and pulp tissues in 64.1% deciduous teeth, and when crown fractures were present (35.9%), there was a higher prevalence for uncomplicated crown fractures (28.5%), such as fracture with loss of dental structure that reaches the enamel and/or dentin, but without involving the pulp; 6.7% teeth suffered a complicated crown fracture and 0.8% a crown-root fracture. As for the supporting tissues, periodontal tissue lesions occurred more frequently (62.5%), in which lateral luxation was the most prevalent (22.3%), followed by subluxation (12.5%) and concussion (11.7%).

The types of treatment performed for the three times of clinical intervention (urgency upon trauma, first evaluation and second evaluation) are listed in Table 1.

Evaluation time 1

In the proservation of traumatized teeth, the time of follow-up of the patients occurred in 60.5% with a time of less than 12 months, with a mean of 14.5 months, and all the children were reevaluated (n = 150). Data referring to sequelae for deciduous teeth (Clinical and Radiographic) can be found in Figure 1.

Data on permanent teeth (Clinical and radiographic) are illustrated in Figure 2.

The statistical analysis (Chi-square test) evidenced an association between the clinical sequelae in deciduous teeth and age at the time of trauma ($p = 0.005$). It was observed that children older than 2 years had a higher prevalence of clinical sequelae, including discoloration of the crown. There was no significant association between radiographic sequelae in deciduous teeth and age at the time of trauma ($p = 0.072$).

There was association between the types of injuries in the supporting tissues and clinical ($p = 0.003$) and radiographic ($p = 0.004$) sequelae in permanent teeth, that is, intrusive luxation in the deciduous tooth showed a relationship with clinical sequelae in permanent successors, mainly enamel hypoplasia. In turn, subluxation and lateral luxation did not cause radiographic sequelae.

Table 1. Type of treatment performed on traumatized deciduous teeth, according to the evaluation period.

Clinical procedure	Urgency	First evaluation	Second evaluation
	n = 256 (%)	n = 256 (%)	n = 131 (%)
Clinical and radiographic follow-up	190 (74.2)	210 (82.0)	104 (79.4)
Polishing the enamel edges	10 (3.9)	1 (0.4)	1 (0.8)
Suturing soft tissues	10 (3.9)	- (0.0)	- (0.0)
Exodontia	16 (6.3)	10 (3.9)	2 (1.5)
Restorative treatment	15 (5.9)	15 (5.9)	1 (0.8)
Endodontics	6 (2.3)	12 (4.7)	- (0.0)
Containment	8 (3.1)	1 (0.4)	- (0.0)
Space maintainers	1 (0.4)	2 (0.8)	3 (2.3)
Discharge	- (0.0)	5 (2.0)	20 (15.3)

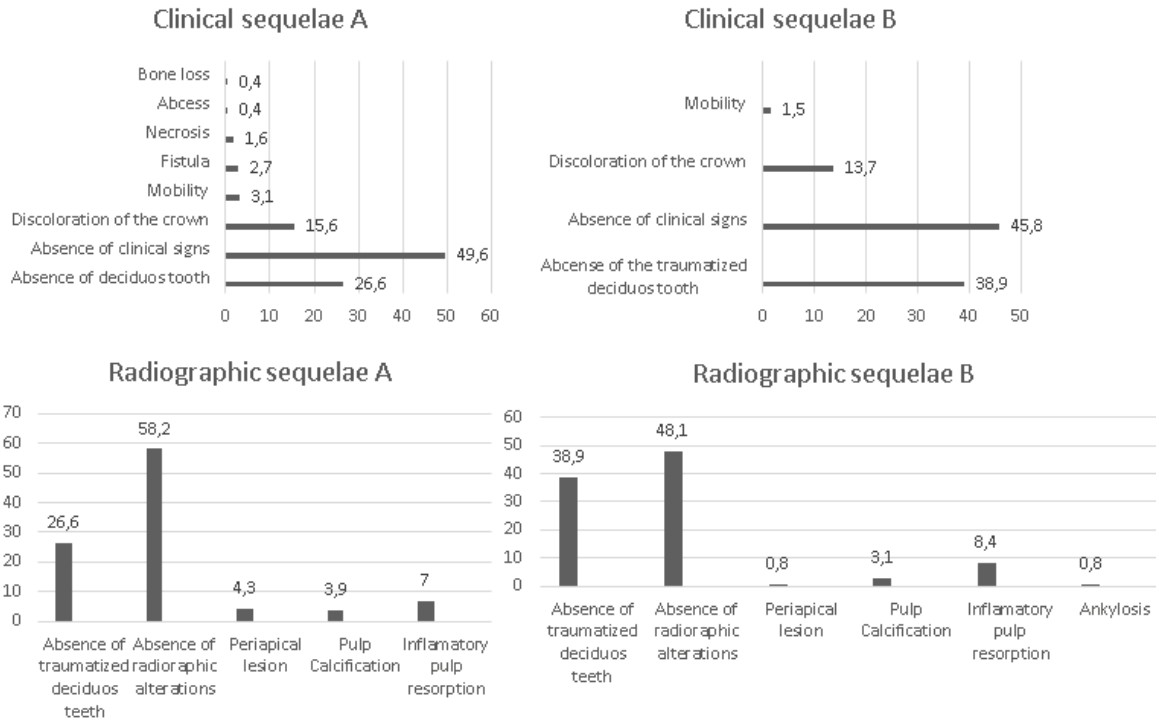

Figure 1. Distribution of the prevalence of clinical and radiographic sequelae in deciduous teeth according to the evaluation time (A-Time 1 and B-Time 2).

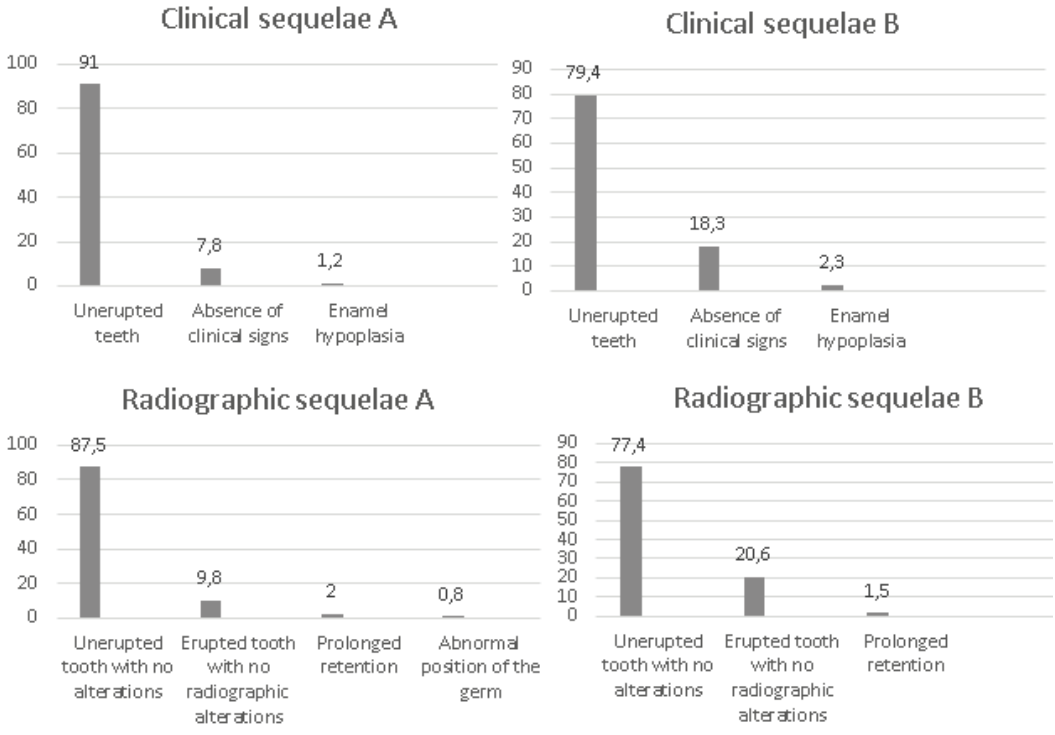

Figure 2. Distribution of the prevalence of clinical and radiographic sequelae in permanent teeth according to the evaluation time (A-Time 1 and B-Time 2).

Evaluation time 2

In the second evaluation for the diagnosis of sequelae for deciduous and permanent teeth, only 131 cases of trauma were examined, that is, 48.8% of the traumatized teeth were not evaluated, since the patients did not attend the scheduled appointment. The average time elapsed in this evaluation was 26 months. These data can be better seen in Figure 1 (Clinical and Radiographic Sequelae for deciduous teeth) and Figure 2 (Clinical and Radiographic Sequelae for permanent teeth).

The Chi-square test showed a significant association between injuries to dental tissue ($p = 0.021$) and the supporting tissues ($p = 0.035$) and the presence of radiographic sequelae in deciduous teeth, indicating that radiographic sequelae, such as inflammatory reabsorption, had a higher prevalence in deciduous teeth after concussion and lateral luxation. In relation to the injuries to the tooth tissues, there was a higher frequency of radiographic sequelae in teeth with enamel fracture.

There was also an association between clinical sequelae in permanent teeth and the time elapsed from the trauma ($p = 0.005$), showing that ages between 24 and 35 months had a higher frequency of clinical sequelae involving the successors.

Discussion

Considered as urgent procedures, not only for dental involvement, but also because of the emotional involvement of the child and his/her companions, trauma to the deciduous dentition, due to its frequency, requires the dental surgeon to be able to attend to the patient, transmitting tranquility to the patient and his/her relatives, establishing a correct diagnosis and an effective therapeutic strategy, in order to minimize possible alterations that can compromise the deciduous teeth and their permanent successors in the long term.

In this way, data collected in the present study indicated that, in an average period of evaluation of 26 months, by analyzing the injuries present at the time of the trauma, when the dental crown was evaluated, enamel fractures are the most prevalent, as well as the findings of Shekhar and Mohan (2011). Conversely, Feldens, Borges, Vargas-Ferreira, and Kramer (2016) pointed to crown fractures as more prevalent, a fact that can be attributed to differences in data collection, and enamel fractures may be undervalued by the parents, in this way, undiagnosed and accompanied by the dental surgeons. In the evaluation of the injuries to the supporting tissues, these occurred more frequently than the injuries to the hard tissues and the pulp, emphasizing lateral luxation, similar to the results detected by Jesus et al. (2010), and contrary to Amorim et al. (2011), who identified subluxation as the most prevalent injury in trauma to the deciduous dentition.

In the proservation of traumatized teeth, the first evaluation (T1) occurred on average at 14.5 months, examining all the children attended at the time of trauma, which contributed significantly to obtain the results of this research, since there is a trend, in longitudinal research involving dental trauma, of parents to abandon follow-up, believing that after the absence of symptoms by the child, the treatment will be completed. In this evaluation, the presence of clinical and radiographic sequelae in the deciduous teeth was diagnosed, confirming the reports found in the literature (Jesus et al., 2010; Amorim et al., 2011; Gurunathan, Murugan, & Somasundaram, 2016). Although a high percentage of traumatized teeth with no clinical alterations (49.6%) and radiographic changes (58.2%) were diagnosed, the presence of more severe sequelae with pulp involvement, especially inflammatory root resorption, was found, confirming Qassen et al. (2014), who reported that it would take more than 180 days for sequelae to be diagnosed in deciduous teeth involved in the trauma, however, post-trauma sequelae can be diagnosed even after more than 4 years of follow-up. These clinical and radiographic findings require more specialized clinical procedures for the treatment, such as endodontics, exodontia, restorative treatments and also the rehabilitation of the space with the use of prosthesis, especially Denari's fixed prosthesis, since the vast majority of children was very young, making impossible the use of the removable prosthesis. In this evaluation (Time 1), there was a positive association between clinical sequelae in deciduous teeth and the age of the child at the time of trauma, showing that children older than 2 years at the time of trauma had more clinical sequelae. These findings may be related to the period of eruption of deciduous teeth, since at this moment the roots of incisors are completely formed, reflecting directly on the supporting tissues and pulp. According to Qassem et al. (2014), sequelae as root inflammatory resorption can be determined by the type of injury as well as by the degree of root maturity of deciduous teeth at the time of injury, which occurs mainly in traumatized teeth that suffered with physiological root resorption at the time of trauma, factors directly related to the child age. Nevertheless, Carvalho et al. (2010) state that there is no association of the age the child suffered trauma with sequelae on traumatized teeth and permanent dentition.

When the permanent teeth were analyzed at Time 1, the main clinical and radiographic sequelae were enamel hypoplasia, eruption disturbance and abnormal position of the germ, although with a much lower percentage than the results of Amorim et al. (2011) and Assunção et al. (2009), which verified 22.4 and 20.2%, respectively. One of the justifications for this lower incidence of sequelae in permanent teeth in the present study may be

related to the short time of follow-up, and another aspect considered is that a large part of the children participating in this study still present chronological age incompatible with the exfoliation of deciduous teeth and eruption of permanent teeth. Still in the evaluation time 1, there was an association between the type of injury to supporting tissues and clinical and radiographic sequelae in permanent successors, noting that clinical sequelae, such as enamel hypoplasia, was more found in situations where the deciduous predecessor suffered from intrusive luxation. Similar results were reported by Carvalho et al. (2010), who evaluated 753 traumatized deciduous teeth, of which 29.3% suffered from intrusive luxation, diagnosing sequelae such as color alteration and/or enamel hypoplasia in permanent successors. Altun et al. (2009), in a prospective 7-year study. examined the sequelae of permanent teeth development following the intrusion of their predecessors and diagnosed that 53.6% of permanent successors exhibited enamel hypoplasia (28.3%). For Mendoza-Mendoza et al. (2015), intrusion is associated with an increased frequency of complications in both deciduous and permanent teeth. In this study, no association was found of radiographic sequelae in permanent successors with subluxation or lateral luxation of deciduous teeth, and one of the justifications is the small number of children studied who presented this type of injury.

In the evaluation time 2, after an average of 26 months, for a reduced number of traumatized deciduous teeth we diagnosed the need for treatment and in 15.3% of the children evaluated, permanent incisors have already erupted and, therefore, the children received discharge. In this evaluation, we observed an association of radiographic sequelae with inflammatory root resorption, associated with concussion and lateral luxation. According to Assunção et al. (2011), the diagnosis of external root resorption can be detected radiographically through some signs such as: thickening of the periodontal ligament, bone rarefaction and pathological root resorption. Cardoso and Rocha (2004) diagnosed this alteration within a period of 46 days to 4 months after the trauma, and after a year, a frequency of 66.7% was observed in teeth with moderate and severe trauma.

In relation to the injuries to dental tissues, there was a higher frequency of radiographic sequelae in teeth with enamel fracture. Finally, an association was detected between clinical sequelae in permanent teeth and time elapsed post-trauma, that is, children evaluated for a period of 24-35 months showed a higher prevalence of sequelae, such as enamel hypoplasia.

Considering the data collected in the present study and the scientific literature, it is clear the importance of patient return in the evaluation visits, as a method to prevent post-trauma sequelae, especially in young children, where the risk is higher. However, this study had limitations, such as the small size of the sample, short time after the trauma and the difficulty of proservation, since some of the patients did not attend the scheduled appointment, impairing a more accurate statistical analysis of the data and the association between the studied variables.

Therefore, it is necessary to increase the sample size in future studies and that the time for evaluation is maintained until the permanent tooth erupts in the oral cavity.

Conclusion

Children older than 2 years at the time of trauma had a higher prevalence of clinical sequelae in deciduous teeth, such as discoloration of the crown.

In traumatized deciduous teeth, radiographic sequelae associate enamel fracture and inflammatory root resorption with concussion and lateral luxation.

Clinical sequelae in permanent successors, such as enamel hypoplasia was more present in situations where the predecessor deciduous has suffered from intrusive luxation;

Guidance to parents and guardians about the importance of evaluation consultations as a method of preventing sequelae.

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