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Prevalence of sequelae in the permanent anterior teeth after trauma in their predecessors: a longitudinal study of 8 years

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Traumatic dental injuries are frequent during childhood and have shown to be a problem of difficult prevention due to their etiology and the age group in which they occur (1–3). The knowledge regarding how, where and when the traumatic injury has occurred is very important in order to make a precise diagnosis during the emergency appointment, and to adopt the right and most efficient clinical procedure (1). When traumatic injuries affect the deciduous teeth, the main objectives are to try to avoid major consequences to the involved tooth and, principally, any damage to the developing germ of the successor tooth (4).

The developmental disturbances in permanent teeth caused by trauma in their predecessors have a prevalence that ranges from 12% to 74%. A relevant factor in this high prevalence is the close anatomical relationship between the apices of primary teeth and their developing permanent successors (5–7). The distance between the apex of the primary central incisor and the incisal edge of the permanent central incisor ranges from 2.97 mm at age 3 to 1.97 mm at age 6 (8).

The sequelae severity depends on the age of the child at the time of injury, the grade of root resorption of the traumatized deciduous tooth, the type and extension of the injury, and the developmental stage of the successor at the time of injury. Independently of the developmental stage of the successor, the types of traumatic injuries which affect them the most are the intrusion and the avulsion of deciduous tooth (7, 9, 10). Furthermore, according to Chaves (11), the younger the child is at the time of injury, the more severe are the developmental disturbances involving the crown of the successor.

The sequelae in permanent teeth caused by traumatic injury in their predecessors are registered according to the following classification: white or yellow-brown discoloration of enamel, enamel hypoplasia, crown dilaceration, root dilaceration, odontoma-like malformation, root duplication, partial or complete arrest of root formation, sequestration of the permanent tooth germ, and eruption disturbances. The discoloration of enamel and the enamel hypoplasia are the most frequent sequelae (5–7, 12).

A clinical and radiographic study performed by Andreasen and Ravn (12) in 103 patients with 213 traumatized deciduous teeth revealed that 88 (41%) successors presented some developmental disturbance. The age of the children at the time of injury ranged from 1 to 12 years, and there was no significant difference between the number of boys and girls. The following developmental disturbances were found: discoloration of enamel in 49 cases (23%), discoloration of enamel and circumferential enamel hypoplasia in 26 (12%), crown dilaceration in six (3%), partial or complete arrest of root formation in four (2%), and root dilacerations in three (1%).

Two hundred seven permanent teeth from 57 boys and 60 girls were evaluated following traumatic injury in their predecessors in order to determine the etiology, the pathogenesis, and the clinical, radiographic and histological aspects of the developmental disturbances related to these traumatisms. The age of the children at the time of injury ranges from ≤ 1 to 7 years in cases of more than one type of injury on the same tooth, only the most serious injury was considered. From the examined teeth, 47 (22.7%) presented discoloration of enamel, 24 (11.6%) enamel hypoplasia, 51 (24.6%) crown dilaceration, 13 (6.3%) odontoma-like malformation, 37 (17.9%) root dilaceration, four (1.9%) root duplication, and 31 (15%) partial or complete arrest of root formation (13).

In 1990, Von Arx (7) re-examined 114 (60%) children of the 195 that had traumatic injuries in their deciduous teeth. The final sample consisted of 255 teeth of 70 boys and 44 girls aged between 1 and 7 years at the time of injury. Data were collected from dental records of 114 patients. Only the most serious sequela was considered. The following developmental disturbances of successors were found: discoloration of enamel and/or enamel hypoplasia in 28 cases (68%), crown dilaceration in seven (17%), root malformation in four (10%), and odontoma-like malformation in two (5%).

Alexandre et al. (1) conducted a study based on the analysis of 180 dental records of 104 boys and 76 girls who suffered traumatic dental injury. The age of the children ranged from 1 to 14 years at the time of injury, and the follow up of eruption of 37 permanent teeth, successors of 59 intruded deciduous teeth was observed. In that study, the sequelae more frequently found in the successors were: eruption disturbances in 18 cases (49%), crown dilacerations in seven (19%), enamel hypoplasia in five (14%), discoloration of enamel in three (8.7%) and root dilaceration in two (5.5%).

The aim of this study was to determine the prevalence of sequelae in the permanent anterior teeth (incisors and canines) following trauma in their predecessors, and to verify the existence of association between the sequelae in the permanent teeth and the type of injury in their predecessors considering the age group at the time of injury.

Materials and methods

This is a retrospective study in which were analyzed data from dental records of 307 children (169 boys and 138 girls), with ages varying from 0 to 10 years, with traumatic injuries to anterior primary teeth (incisors and canines), who came to the Dental Traumatism Clinic of the Pediatric Dentistry Clinic of the State University of Rio de Janeiro (UERJ), Rio de Janeiro, Brazil, from March 1996 to December 2004. The present study was approved by the Committee of Ethics in Research from the Pedro Ernesto University Hospital, from the UERJ. The sample was collected from 753 traumatized deciduous teeth and their successors. The fully erupted permanent successors (174) were examined and an assessment of developmental disturbances was made. In addition to personal information from the patient, such as name, address, date of birth, and sex, we also collected through a trauma form information concerning the history of traumatic injuries (cause and type of injury, place, date and circumstances under which the trauma occurred, lesions to soft tissues, previous trauma history) in accordance with the World Health Organization classification of injury types modified by Andreasen and Andreasen (13).

All children were examined and assisted by Pediatric Dentistry graduate students previously trained and constantly supervised by the same professor of the Pediatric Dentistry Clinic.

The following decreasing order of severity was established as a criterion in order to classify the sequelae: sequestration of the permanent tooth germ, odontomalike malformation, partial or complete arrest of root formation, crown dilaceration, root dilaceration, root duplication, discoloration of enamel and/or enamel hypoplasia, and eruption disturbances. In cases in which the same tooth presented more than one sequela only the most serious one was considered.

Clinical and radiographic (intra and extra-oral techniques) follow up of the patients was carried out periodically (weekly, monthly, etc.) according to the severity and type of injury.

The main parameter of comparison of analyzed variables was the age of patients at the time of injury. Association among variables was verified statistically using the chi-squared test, with the level of significance set at 5%.

Results

The prevalence of traumatic dental injuries was slightly higher in boys, with 55% in comparison with 45% in girls, but this difference was not statistically significant.

The most common causes of trauma were falls (82.7%), biking accidents (5.2%), and impacts with other children (3.6%). Most of the accidents occurred at home (68.7%), but they were also frequent on the street (15.3%) and at school (8.8%). The most affected tooth was the right central incisor, followed by the left one, but there was no statistically significant difference (5%). The number of follow ups per age group is presented in Fig. 1.

From the 753 successors of the traumatized primary teeth, 543 (72.1%) were regularly followed by the complete eruption of these teeth. Three hundred sixty-nine of them (49.0%) did not erupt because the children were still too young and 210 (27.8%) were lost to follow up. From the remaining 174 fully erupted permanent successors, 89 (51.1%) presented some developmental disturbances and 85 (48.9%) demonstrated no sequelae. The more frequent sequelae were discoloration of enamel and/or enamel hypoplasia (46.08%), disturbances of eruption (17.97%), and root dilaceration (15.73%) (Fig. 2).

The intrusions of primary teeth were the type of injury that most commonly caused sequelae in successors in all



age groups, except from 8 to 9 years. Nevertheless, it was not possible to find association between the type of injury in primary teeth and the occurrence of sequelae in their successors in any studied age group ($P \le 1.00$) (Table 1).

Discussion

Traumatic injuries in anterior primary teeth can affect their successors due to the close anatomical relationship between the apices of primary teeth and the developing permanent successors, with a prevalence of developmental disturbances in permanent teeth ranging from 12% to 74% (5–7). In this study, 51.1% of the successors presented some developmental disturbance.

In this research, the most serious malformations involving the dental crown occurred in children between 0 and 4 years of age at the time of injury (11).

The most observed sequelae in the successor teeth in the present study were discoloration of enamel and/or enamel hypoplasia in children aged 0–8 years. In most cases, intrusion was the type of injury that most affected

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Age groups	Enamel discoloration/	Crown	Bud	Odontoma- like	Root	Root	Eruption	Cuet	Others
(years)	Πγρυμιαδία	ullacerations	sequestration	manormation	unacerations	uupiication	uistui bailce	Uysi	Others
0–1	2 (2.25)		1 (1.12)	1 (1.12)			1 (1.12)		1 (1.12)
1–2	9 (10.11)	7 (7.87)	、	· · ·		2 (2.25)	4 (4.50)	1 (1.12)	2 (2.25)
2–3	11 (12.36)						3 (3.37)		2 (2.25)
3–4	6 (6.74)	1 (1.12)			2 (2.25)		3 (3.37)		
4–5	2 (2.25)				4 (4.50)		1 (1.12)		
5–6	6 (5.62)				5 (5.62)				
6–7	2 (2.25)				3 (3.37)		2 (2.25)		
7–8	4 (4.50)								
8–9							1 (1.12)		
9–10							1 (1.12)		
Total	41 (46.08)	8 (8.99)	1 (1.12)	1 (1.12)	14 (15.73)	2 (2.25)	16 (17.97)	1 (1.12)	5 (5.62)
Values are expressed as n (%).									

Table 1. Number of cases with developmental disturbances per age group

the primary tooth, and common enamel hypoplasia resulted from this type of traumatic injury (2, 5, 13). According to Diab and Elbadrawy (6), the discoloration of enamel affects the permanent teeth of children aged 2–7 years at the time of injury. Nevertheless, no association was found between a specific type of injury and the occurrence of this type of sequela (7, 14).

The disturbances in the eruption of permanent successor teeth following trauma include: impaction, ectopic eruption, delayed eruption, scar plate formation, and ankylotic primary teeth, and they are the consequences of changes in the support tissue which involves the successor germ (6, 14).

In this study, eruption disturbances were considered a secondary sequela (clinical finding) associated with any other developmental disturbances (13, 15). In spite of the fact that only the most serious sequela had been considered for classification, this type of secondary disturbance presented a high prevalence (17.97%).

Crown dilaceration is more frequent following an intrusion or avulsion of primary teeth, and the most affected age group is between 1.5 and 3.5 years at the time of injury (1, 12–14, 16–18). The results of this study regarding age of children at the time of injury and type of traumatic injury are similar to those reported in the literature. However, the prevalence of crown dilacerations found here, 9%, was three times greater than the results presented by other studies (12, 14, 17, 18).

Root dilaceration affected 14 of 89 permanent successors that presented any sequela. From these 14 teeth with root dilaceration, six were caused by intrusion in children who were between 3 and 5 years of age. This occurs due to the fact that traumas which occur in children over 4 years of age have a greater probability of affecting the successor's developing germ in the initial stages of root formation (Nolla's stage 6) (11, 13, 18, 19).

The cases of root duplication, bud sequestration, and odontoma-like malformation were caused by intrusions in children aged 0-2 years at the time of injury. Such disturbances are rare, usually resulting from intrusions which affect children until 3 years of age, during Nolla's stages 1-3 (6, 19–21).

There was no significant statistical association between the occurrence of sequelae in the permanent teeth and type of injury in their predecessors in the studied age groups. Meanwhile intrusion and avulsion in primary teeth were the types of injury that most caused sequelae in their successors (1, 7, 9, 10).

The purposes of the treatment of traumatic injuries in primary teeth are trying to avoid major consequences to the involved tooth, and, most importantly, to its developing successor (1, 4). However, when bleeding lesions or tooth displacement do not occur, more often parents do not perceive the occurrence of a dental injury and they only look for a dentist when a post-traumatic sequela appears (3).

The periodic follow-up examinations facilitate and expedite the provision of adequate treatment for children sustaining any sequela in the permanent anterior teeth following trauma in their predecessors. Most times, this procedure will lead to a better prognosis, which can minimize or avoid post-traumatic sequelae in children, and minimize cost to parents (15, 21).

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