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Traumatic injuries to the primary dentition and effects on the permanent successors – a clinical follow-up study

Sennhenn-Kirchner S, Jacobs H-G. Traumatic injuries to the primary dentition and effects on the permanent successors – a clinical follow-up study. © Blackwell Munksgaard, 2006.

Abstract – This study investigated problems in the permanent dentition that, according to history and records, were attributable to dental alveolar injuries of the primary dentition. 106 children have been involved in the study, who had experienced primary anterior tooth trauma affecting a total of 200 teeth. Thirty-nine patients (81 teeth) were available for follow-up examinations. In 25% of the cases followed up, damage was found on the successors in the secondary dentition (16 children/20 teeth). In half of the cases, a comparatively mild form of lesion like enamel discoloration was observed. This was the result of an injury during the tooth maturation process causing enamel hypoplasia. Clinically more relevant were the dental deformities: cessation of root formation or retention caused by ankylosis, which made up the remaining 50% of cases. This was confirmed by clinical long-term observation. The different effects on the permanent teeth can only be detected by radiography after an interval of several months or may even be clinically assessed only after the eruption of the clinical crown.

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Key words: tooth injuries; teeth; primary; child; preschool; intrusion injuries; deciduous; follow-up study

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Injuries to the teeth and primary dentition are among the most common trauma found in the maxillofacial region. Thirty to forty per cent of children incur at least one injury to their primary teeth and incidence is not related to gender (1–4). The teeth most commonly affected in both primary and permanent dentition are the upper central incisors, because of their exposed position in the dental arch. With a statistical gap in incidence, they are followed by traumatic injuries of the upper and lower lateral incisors and the upper canines (5–8).

Injuries to other teeth are rare and are reported in conjunction with serious traumatic injuries of the facial skull (9). Causes of primary anterior tooth trauma are falls when infants are in a stage of insufficient motor control, and sports and traffic accidents when they grow older (10). Child abuse is mentioned by Andreasen (11) as a further cause of anterior tooth trauma in children. Apart from aesthetic and functional impairment, the close proximity of the developing permanent tooth germ renders it vulnerable to trauma transmitted during luxation injuries (12).

The type and extent of traumatic tooth injuries depend on the direction and intensity of the acting force. This traumatic force frequently gives rise to damage to the hard substance of the tooth, while indirect blunt forces more often result in damage to the periodontium (13). A classification of traumatic dental injuries was proposed by Andreasen and Andreasen (14) as follows: (1) injuries to the hard dental tissue and pulp; (2) injuries to the hard dental tissue, pulp, and alveolar process; and (3) injuries to the periodontal tissues (14). The effects on permanent teeth vary. Enamel hypoplasia, dental deformities, absent root development, and retention of the

secondary teeth caused by ankylosis are described as possible sequelae (15–17).

Method

Of the 106 children, who were treated for anterior tooth trauma in primary dentition in the Department of Oral Surgery in the Center for Oral and Maxillofacial Diseases of the University of Goettingen during a 5-year period, a follow-up examination of 39 patients was performed under an anamnestic, clinical, radiological perspective. One patient appeared twice in the analysis, because he experienced accidents on two different occasions. Data regarding findings on the day of the accident were derived from the records and transferred to a findings sheet (Fig. 1). The follow-up examination was performed according to the scheme shown in Fig. 2.

Results

Of the 106 patients, 45 were girls (42%) and 61 were boys (58%), and were sampled on the basis of their medical files. They experienced a total of 108 accidents, in which 200 primary anterior teeth were seriously injured. The age distribution of the time of the accidents showed that the traumata were already experienced during the first year of life. There is a peak between the second to fourth year, followed by a decline in frequency (Fig. 3).

Examination form
for follow-up examinations of dentoalveolar traumatic injuries to primary dentition

Name:

Date of Birth:

Family Dentist:

Date of primary tooth trauma:

Cause of the trauma:

Teeth injured:

53	52	51	61	62	63
63	62	61	71	72	73

Type of tooth injury:

Soft tissue injury:

Radiological examinations at the time of initial examination:

Management at the time of initial examination:

Other injuries or diseases to the gnathofacial region at an earlier or later point in time:

Presence of a general disorder during the first years of life:

Regular medication:

Fig. 1. Results of examination of traumatized primary teeth.

Examination form
for follow-up examinations of permanent dentition

Date of follow-up examination:

Sensitivity:

Grade of mobility:

Enamel hypoplasia:

Crown/ root malformation:

Retention/ Dislocation:

Time of eruption
normal:
delayed:
premature:

X-ray:

Photo:

Comments:

Fig. 2. Concept for follow-up examination of permanent teeth.

Table 1 shows the site of injury. While upper central incisors constituted 70.5% of the traumatized teeth, lower central incisors were only affected in 3.5%. Upper lateral incisors were involved in 21%, and lower in merely 0.5%. Only canines of the upper jaw were affected, and these constitute 4.5% of the total injured primary teeth. The various types of trauma experienced are shown in Fig. 4. Of the 106 affected children (200 teeth), 39 (81 teeth) were available for follow-up examinations. In a quarter of the traumatic injuries to the primary anterior teeth which were followed up, damage was detected to the successors of the secondary dentition (16 patients/20 teeth). The distribution is provided in Table 2.

Enamel hypoplasia was found as a mere discolouration in four teeth. In three there were faults of enamel without discolouration, and in a further three a combination of the two was observed (Fig. 5a,b).

Fig. 3. Age of the patients at time of accident.

Table 1. Reasons for injuries of the primary dentition

Cause of injury	Number of affected teeth (%)
Fall	87 (80.6)
Road accident	13 (12.0)
Blow	3 (2.8)
No details	5 (4.6)
Total	108 (100)

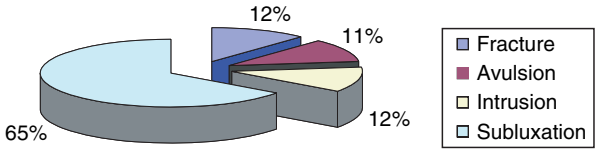

Fig. 4. Proportions of different kinds of injuries (%, $n = 200$).

Five teeth of the secondary dentition showed malformations, one each limited to crown or root (Fig. 6a,b), and in the remaining three cases both crown and root were affected (Figs 7a,b and 8a,b). Eruption was disturbed in five teeth, with two teeth being affected in the form of ectopic partial retention, two teeth in the form of complete retention with displacement, and one tooth as retention without displacement. It became obvious that secondary damages were most frequently caused by intrusion injuries (Fig. 9). Table 3 shows the association of secondary damages affecting the permanent dentition with the age at the time of the accident. The distribution of different kinds of damage is shown in Fig. 10. The type of primary tooth trauma is related to the secondary damage in Table 4. Although anterior tooth traumatic injuries were more common among children of the higher age groups, the proportion of secondary damage at 66% was considerably higher in the younger age groups. Relating trauma type to subsequent secondary damage reveals that malformations of permanent teeth occurred only after intrusion injuries.

Discussion

This investigation relates secondary damage of the permanent dentition with prior traumatic injuries to primary anterior teeth. It is of special interest to describe the associations between the age of the child at the time of the accident, the type of trauma, and the consequences of the trauma. The frequencies of injury found in this study with respect to the various types of teeth are to a large extent in line with the observations stated in the references (1, 18, 19). As described by Euler as early as 1939 (20) and later by Hellwig (21), the alveolar bone of children is characterized by a high degree of flexibility because of incomplete mineralization. This explains the difference (88%:12%) in the ratio of luxations to damage of the hard tissue. There are many

Table 2. Distribution of different kinds of developmental disturbances ($n = 20$)

Sequel	Number of teeth (%)
Hypoplasia	10 (50)
Deformation of crown and/or root	5 (25)
Irregular eruption (ankylosis, delayed or ectopic eruption)	5 (25)
Total	20 (100)

Fig. 5. (a) Enamel hypoplasia following intrusion trauma at the age of 2.8 years. (b) Circular enamel hypoplasia following subluxation of the teeth 51, 61 and 62 at the age of 3.4 years.

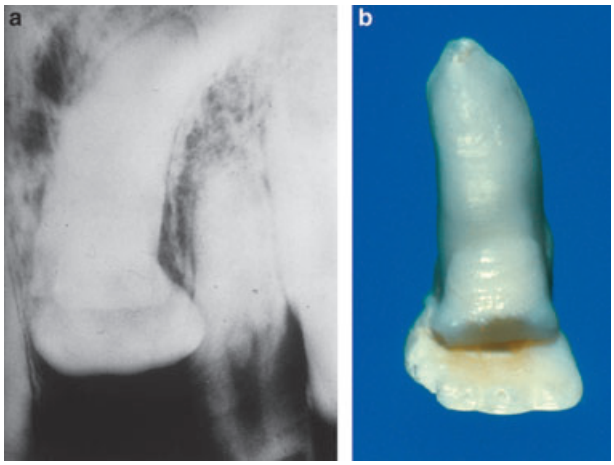

Fig. 6. Crown malformation following intrusion of tooth 61 at the age of 2 years irregular root formation of the neighbouring teeth, (a) radiological and (b) postoperative findings.

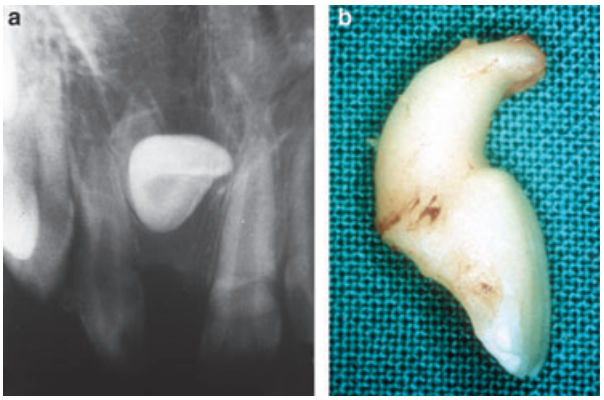

Fig. 7. Sequel of intrusion of deciduous tooth 51 at the age of 2 years, (a) radiological and (b) postoperative findings.

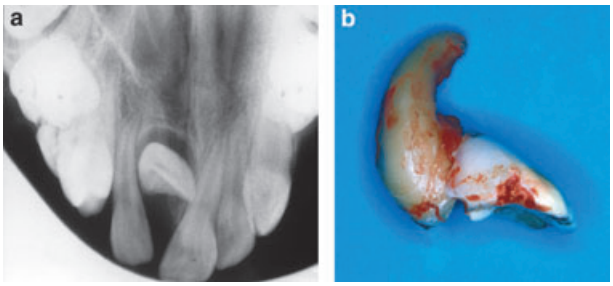

Fig. 8. Severe crown and root deformation of tooth 11 following traumatic experience (intrusion of 51 and 61) at the age of 16 month, (a) radiological and (b) postoperative findings.

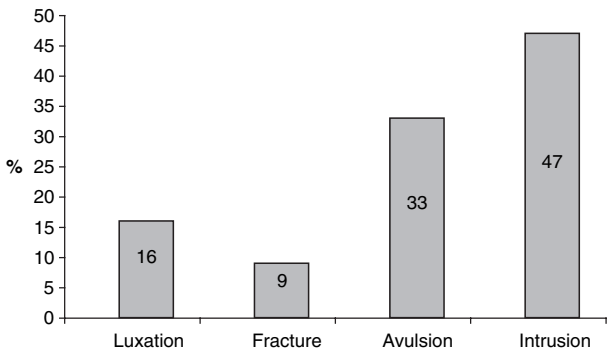

Fig. 9. Frequency (%) of development disturbances referring to form of traumatic injuries.

Table 3. Number of patients with sequelae on successors – differentiated by age at time of trauma

Age of children at time of injury	Number of patients followed-up	Patients with sequelae (%)
0–3 Jahre	15	66
3–7 Jahre	25	24

references regarding the effects of dental alveolar injuries to the primary dentition, many times in the form of case reports (22–24). The results of studies

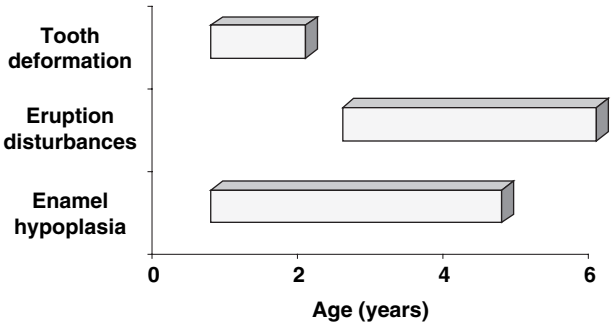

Fig. 10. Relationship between patients' age at time of injury and kind of development disturbance.

Table 4. Kind of injury affecting primary dentition and sequelae affecting successors

Kind of injury	Number of teeth	Sequel	Number of teeth
Intrusion	8	Deformation of crown and/or root	5
		Irregular eruption	1
		Enamel hypoplasia	2
Subluxation	9	Irregular eruption	3
		Enamel hypoplasia	6
Avulsion	2	Enamel hypoplasia	2
Root fracture	1	Irregular eruption	1

regarding the frequency of secondary damage caused by traumatic injuries vary between 12 and 69% (25–30). In this study, secondary damage on the permanent teeth was observed in 25% of the children, who underwent follow-up examination. Prior studies (16–19, 31–34) support the finding of this study that intrusion injuries (here 47%) is the most frequent cause of developmental disturbance. In this investigation, a definite link between intrusion in early childhood and severe malformations of permanent teeth, affecting both the crown and the root, can be established. In this context, Holan et al. point out that extra-oral X-rays are of no diagnostic advantage (35). Complete avulsion, as already described by Ravn (31), represents the second most frequent cause of secondary damage in this investigation. Because of the low intensity of the injury force, incomplete dislocation injuries of primary teeth result in only 16% of cases of impairment of odontogenesis. The results of this study indicate that damage to the secondary dentition following fractures of primary teeth is unlikely to occur. Taking into consideration the age of the children at the time of accident, it becomes apparent that 66% of patients up to an age of 3 years suffered from sequelae in contrast to only 24% of patients older than 3 years (36). According to Selliseth (27) a possible cause could be the incomplete level of mineralization of bone and dental germ at that time. The average age at the time of the accident was

1.6 years in cases of severe morphologic dental deformations, which is in line with the findings of studies by Ravn as well as Watzek and Skoda (26, 37).

Conclusions

Immediately after a dental alveolar trauma in the primary dentition, no definite statement can be made regarding the possible secondary damage despite clinical and radiological examinations. The type of traumatic primary tooth injury combined to the age of the child at the time of the accident can indicate the probability of subsequent secondary damages. Thus, the importance of accurate exploration and documentation of the accident becomes apparent. Especially in cases of intrusion injuries diagnosed in children of <3 years of age, we recommend regular follow-ups. In particular preeruptive radiology is recommended, to achieve early detection and treatment of possible severe developmental disturbances.

References

1. Andreasen JO, Ravn JJ. Epidemiology of traumatic dental injuries to primary and permanent teeth in a Danish population sample. Int J Oral Surg 1972;1:235–9.
2. Von Arx T. Traumatology in the deciduous dentition I. The clinical and therapeutic aspects. Schweiz Monatsschr Zahnmed 1990;100:1195–204.
3. Zadik D. A survey of traumatized primary anterior teeth in Jerusalem preschool children. Community dent Oral Epidemiol 1976;4:149–51.
4. Jacobsen I, Sanges G. Traumatized primary anterior teeth. Acta Odontol Scand 1978;36:199–204.
5. Taatz H. Verletzungen der Milchzähne und ihre Behandlung. In: Reichenbach E, editor. Kinderzahnheilkunde im Vorschulalter. Leipzig: Barthverlag; 1979. p. 343–68.
6. Oikarinen K, Kassila O. Causes and types of traumatic tooth injury treated in a public dental health clinic. Endod Dent Traumatol 1987;3:172–7.
7. Andreasen JO. Etiology and pathogenesis of traumatic dental injuries. Scand J Dent Res 1970;78:329–42.
8. Mutajuka F. Das Frontzahntrauma bei 800 Patienten an der Zahn- und Kieferklinik zu Köln seit dem 1. Januar 1983 bis zum 31. Dezember 1985. Med. Diss. Köln 1988.
9. Schneider D. Injuries to the teeth and the alveolar process. Stomatol DDR 1981;31:456–65.
10. Garcia-Godoy F, Morban-Laucer F, Garcia-Godoy FM. Primary teeth traumatic injuries at a private pediatric dental center. Endod Dent Traumatol 1987;3:126–29.
11. Andreasen JO. Traumatology of the teeth. Hannover: Schlütersche Verlagsanstalt; 1988.
12. Schroeder HE. Orale Strukturbiologie. 5. Auflage. Stuttgart: Thieme Verlag; 2000.
13. Drücke B, Reinhardt S. Versprengte Zahnfragmente im Weichgewebe nach Frontzahntrauma. Quintessenz 1995;46:173–82.
14. Andreasen JO, Andreasen FM. Injuries to developing teeth. Textbook and colour atlas of traumatic injuries to the teeth. Copenhagen: Munksgaard; 1994. p. 457–94.
15. Hochban W. Traumatology of incisors – surgical aspects. Zahnärztl Mitt 1994;84:2392–9.
16. Andreasen JO, Sundstöm B, Ravn JJ. The effect of traumatic injuries to primary and permanent teeth on their permanent successors. Scand J Dent Res 1971;79:219–83.
17. Jacobs HG. Oral and maxillofacial traumatology. München: Hanser Verlag; 1983.
18. Diab M, el Badrawy HE. Intrusion injuries of primary incisors. Part III: Effekts on the permanent successors. Quintessence Int 2000;31:377–84.
19. Kramer PF, Zembrutzki C, Ferreira SH, Feldens CA. Traumatic dental injuries in Brazilian prescool children. Dent traumatol 2003;19:299–303.
20. Euler H. Abnormalities, malformations and mutilations of human teeth. München: Lehmann Verlag; 1939.
21. Hellwig E. The treatment of traumatic injuries of incisors – an interdisciplinary task. Zahnärztl Mitt 1994;84:2376–78.
22. Thor AL. Delayed removal of a fully intruded primary incisor through the nasal cavity: a case report. Dent Traumatol 2002;18:227–30.
23. Cunha RF, Pugliesi DM, Correa MG, Assuit DM. Early treatment of an intruded primary tooth: a case report. J Clin Pediatr Dent 2001;25:199–202.
24. Merkle A. Complete intrusion of a maxillary right primary central incisor. Pediatr Dent 2000;22:151–2.
25. Zellner R. Enamel malformations in second dentition following traumatic injuries of deciduous teeth. Zahnärztl Prax 1956;7:1–2.
26. Ravn JJ. Sequelae of acute mechanical traumata in primary dentition. J Dent Child 1968;35:281–9.
27. Selliseth NE. The significance of traumatized primary incisors on the development and eruption of permanent teeth. Eur Orthodont Dent Soc 1970;46:443–59.
28. Mehnert H. Milchzahnverletzungen auf das bleibende Gebiss. Österr Z Stomatol 1974;71:407–13.
29. von Arx T. Traumatologie im Milchgebiss II. Schweiz Monatsschr Zahnmed 1991;101:56–73.
30. Ishikawa M, Satoh K, Miyashin M. A clinical study of traumatic injuries to deciduous teeth. (3) Influence on their permanent successors. Shoni Shikagaku Zasshi 1990;28:397–406.
31. Ravn JJ. Development disturbances in permanent teeth after exarticulation of their primary predecessors. Scand J Dent Res 1975;83:1313–4.
32. Bassiouny MA, Giannini P, Deem L. Permanent incisors traumatized through predecessors: sequelae and possible management. J Clin Pediatr Dent 2003;27:223–8.
33. Holan G, Ram D. Sequelae and prognosis of intruded primary incisors: a retrospective study. Pediatr Dent 1999;21:242–7.
34. von Arx T. Deciduous tooth intrusions and the odontogenesis of the permanent teeth. Developmental disorders of the permanent teeth following intrusion injuries to the deciduous teeth. Schweiz Monatsschr Zahnmed 1995;105:11–7.
35. Holan G, Ram D, Fuks AB. The diagnostic value of lateral extraoral radiography for intruded maxillary primary incisors. Pediatric Dent 2002;24:38–42.
36. Flores MT. Traumatic injuries in the primary dentition. Dent Traumatol 2002;18:287–98.
37. Watzek G, Skoda J. Milchzahntraumen und ihre Bedeutung für die bleibenden Zähne. Zahn Mund Kieferheilkd 1976;64:126–33.