Dental Traumatology

Dental Traumatology 2012; **28**: 81–86; doi: 10.1111/j.1600-9657.2011.01032.x

Traumatic dental injuries and their association with malocclusion in the primary dentition of Irish children

Eimear Norton, Anne C. O'Connell

Division of Public and Child Dental Health, Dublin Dental University Hospital, Trinity College, Dublin 2, Ireland

Correspondence to: Eimear Norton, Division of Public and Child Dental Health, Dublin Dental University Hospital, Trinity College, Dublin 2, Ireland
Tel.: +353 1 612 7303
Fax: +353 1 612 7298
e-mail: eimear.norton@dental.tcd.ie; anne.oconnell@dental.tcd.ie

Accepted 5 June, 2011

Abstract – *Aims*: This study sought to establish the prevalence of traumatic dental injuries in the primary dentition of Irish children and to investigate the relationship between dental trauma and non-nutritive sucking habits. *Materials and methods*: Following ethical approval, a variety of schools and crèches in an urban setting were identified and parents of over 1000 children were contacted. Consent was obtained, and parental questionnaires were completed prior to a clinical examination of the children by one operator in a non-dental setting. Signs of previous dental trauma were noted, and overbite and overjet were measured. *Results*: Eight hundred and thirty-nine children were examined. The prevalence of dental trauma was 25.6%, with boys more frequently affected. The most commonly observed dental injury was fracture of enamel (39.4%), followed by crown discolouration (20.2%). Only 38.8% of the children with a reported history of trauma sought dental care. Non-nutritive sucking habits were reported in 63.5% of the sample, and these habits, if prolonged, were significantly associated with anterior open bites and increased overjet ($P < 0.001$). Using regression analysis, it was established that the risk of dental injury is 2.99 times greater if the child has an overjet >6 mm and 2.02 times greater if the child has an anterior open bite. *Conclusions*: Non-nutritive sucking habits are associated with the establishment of anterior open bite and increased overjet in the primary dentition. These malocclusions are, in turn, significantly associated with an increased prevalence of dental trauma in the primary dentition.

Dental trauma to the primary dentition is a common occurrence. International epidemiological surveys have estimated that up to 36% of children experience dental trauma to their primary dentition (1). Dental trauma often occurs in the preschool population because children learning to walk have poor balance and are subject to frequent falls (2). These injuries represent painful, distressing events and may result in negative long-term physical, aesthetic and psychological consequences for the children.

The close anatomical relationship between the roots of the primary incisors and the developing permanent tooth germs allows the impact of any trauma to the primary dentition to be transmitted to the permanent teeth, which may result in odontogenic disturbances (3). In addition to the physical damage to the dentition, the emergency dental visit is challenging for the child, the parents and the dentist (4, 5). Early negative dental experiences have been linked with the development of significant dental anxiety in children (6), especially when the dental trauma is the child's first dental experience (7). Treatment under general anaesthesia is often required which has additional health risks as well as cost and time implications. Extraction of the traumatised primary tooth is often recommended to minimise pain, interference with function and disruption to the developing permanent tooth (8). Loss of an anterior dental unit impacts detrimentally on facial appearance, which in turn may affect the development of social skills, peer relationships and self-esteem of children (9).

The prevalence of dental trauma in the primary dentition has been studied internationally (Table 1). However, little agreement has been reached on an overall prevalence, with figures ranging from 9.4% (10) to 41.6% (11) (Table 1). This variation is largely because of differences in study populations, inclusion criteria, classification of trauma used and the geographical and behavioural differences, such as activity levels of preschool children between the study locations and countries (12). No such data are available in Ireland, since previous National Dental Surveys, undertaken in 1964, 1983 and 2002, examined dental trauma in permanent incisors only (13).

Knowledge of the aetiological and predisposing factors for dental trauma in the primary dentition is useful to dentists to educate on prevention of dental injury. Non-nutritive sucking habits, either digit or pacifier, when prolonged, can modify growth and effect changes

Table 1. Prevalence of dental trauma in the primary dentition

Name	Year & Country	Sample	Age	Prevalence (%)
Andreasen & Ravn (14)	1972 Denmark	487	Not indicated; retrospective analysis of clinical records	30
Bijella et al. (15)	1990 Brazil	576	10–72 months	30.2
Forsberg & Tedestam (16)	1990 Sweden	1635	1–6 years	12
Jones et al.(17)	1993 USA	493	3–4 years	23
Jones & Nunn (18)	1993 England	135	3 years	12.6
Kramer et al. (19)	2003 Brazil	1545	0–6 years	35.5
Granville-Garcia et al. (20)	2006 Brazil	2651	1–5 years	36.8
Rodríguez (21)	2007 Brazil	543	2–5 years	34.2
Oliveira et al. (10)	2007 Brazil	892	5–59 months	9.4
Robson et al. (22)	2009 Brazil	419	0–5 years	39.1
Jorge et al. (11)	2009 Brazil	519	1–3 years	41.6
Ferreira et al. (23)	2009 Brazil	3489	0–5 years	14.9
Wendt et al. (24)	2010 Brazil	571	12–7 months	36.6
Feldens et al. (25)	2010 Brazil	888	3–5 years	36.4

in the occlusion including increased overjet and anterior open bite (26, 27). Increased overjet has been associated with dental trauma in the permanent (28) and primary dentitions (22, 25, 29). Anterior open bite has been examined as an aetiological factor in dental trauma in the primary dentition with conflicting results (10, 25).

This is the first study to examine the prevalence of dental trauma in the primary dentition of Irish children. In addition, we sought to examine the relationship between increased overjet, anterior open bite and non-nutritive sucking habits and the prevalence of these injuries.

Materials and methods

Ethical Approval was obtained from the Faculty of Health Sciences Research Ethics Committee of Trinity College, Dublin. Permission was received from 28 crèches and primary schools to access children aged <84 months with primary anterior teeth present. Information packs which contained a letter explaining the study, a parental questionnaire and a consent form were delivered to each institution for distribution to the parents/guardians of eligible children. The parental questionnaire requested demographic details as well as information on previous dental injuries and non-nutritive sucking habits for the child. Consent from a parent/guardian and the child's assent for examination was required.

The minimum sample size required to establish significance was calculated using a power calculation. Using a prevalence figure of 30% (14), the minimum sample size required was 126 children, for a power of 90%. To negate any potential inaccuracies in the power calculation and to compensate for an expected poor response rate, the number of children targeted in the study was substantially higher (1397 children). A total of eight hundred and thirty-nine (839) children between 9 and 84 months were examined in the study.

The clinical examinations took place in the schools and crèches. A single trained dentist examined the children in the classroom individually using natural light. Cross-infection protocols were strictly observed. The examination for signs of dental trauma included only maxillary and mandibular primary incisors and canines and was based on the classification described by Andreasen et al. (30). Radiographs and pulpal sensibility tests were not recorded: pulpal involvement was assessed through the presence of discolouration and the presence of fistulous tract without signs of caries.

Anterior teeth with structural loss because of caries were not included in the analysis (24). Similarly, the presence of infection was only included in the analysis in the absence of a carious reason for necrosis of the tooth. Periodontal injuries were noted when the traumatised tooth was displaced relative to the adjacent teeth. Premature loss of an anterior tooth compared with the homologous tooth (i.e. its mobility) and without a history of extraction was recorded as an avulsion. Where more than one injury per tooth was noted, only the most severe injury was recorded in the analysis. This hierarchy of injury diagnoses (Table 2) was based on the likelihood of the injury causing damage to the permanent successor (3, 31).

Overbite was assessed visually based on the vertical overlap of the incisors in the occlusal position. It was recorded as positive overbite, no overbite (edge to edge incisors) or anterior open bite. The overjet was measured with the child's teeth in the centric occlusal position using a disposable plastic Index of Orthodontic Treatment Need (I.O.T.N.) ruler [Ortho Care (UK) Limited, Oxford Place, Bradford, West Yorkshire, UK]. The ruler was placed perpendicular to the maxillary incisors when the teeth were in occlusion, and the measurement was recorded (Fig. 1). The overjet was recorded as either: 0–3.5 mm, 3.5–6 mm, >6 mm or reverse overjet as indicated on the I.O.T.N. ruler.

Parental questionnaires were evaluated and compared with the clinical examination for each child. Similarities and differences between reported trauma and the clinical findings were assessed.

Statistical analysis

All data were recorded on Microsoft Excel 2007® (Microsoft Inc., Redmond, WA, USA). Statistical analysis was carried out using R® STATISTICAL SOFTWARE (www.r-project.org). Intra-examiner calibration was analysed using the Kappa–Cohen test. Chi-squared and Wilcoxon rank tests were used to compare groups of data. Logistic regression models were used to identify the factors predictive of dental trauma in the primary

Table 2. Hierarchy of injury diagnoses included in analysis

1	Intrusive luxation
2	Avulsion
3	Luxations
4	Discolouration
5	Infection
6	Complicated crown fractures
7	Enamel dentine fractures
8	Enamel fractures

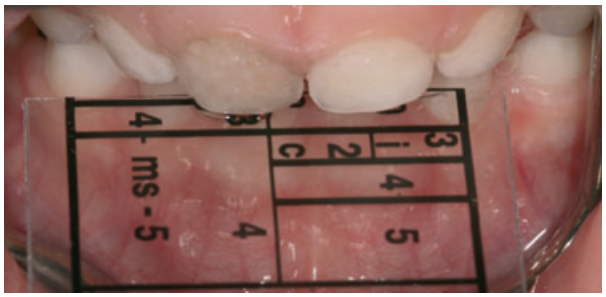

Fig. 1. Measurement of the overjet with the I.O.T.N. ruler in a child with a discoloured left primary central incisor OJ < 3.5 mm.

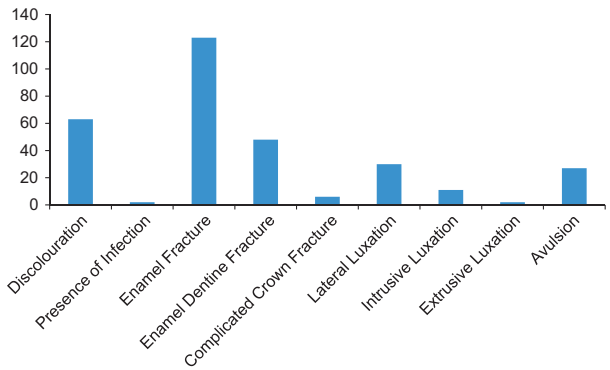

Fig. 2. Frequency of injury by diagnosis.

dentition. Associations were considered significant when the *P* value < 0.01.

Results

A total of 1397 children under 84 months in the sample schools and crèches were eligible, and 839 were examined in the study. The principal reason for non-inclusion was refusal of parental consent. Other reasons included refusal of child consent, exfoliation of primary anterior teeth or absence from school on the day of the clinical examination. The overall response rate was 60%. There was even distribution of the sexes with 50.1% boys and 49.9% girls examined. The average age of the children was 55.1 months (4.5 years), with a range from 9 to 84 months.

The clinical examination identified 306 traumatised anterior primary teeth in 215 children, yielding a prevalence of 25.6% of dental trauma in the primary dentition. Of these 215 children, 65.5% had trauma to one tooth only. The prevalence of dental trauma increased with increasing age up to 72 months from 0% in those < 12 months and peaked between 49 and 72 months. There was no significant difference between the proportions of boys (52.1%) and girls (47.9%) affected. The maxillary teeth were most frequently traumatised (95.4%). The most frequently affected tooth was the upper right primary central incisor, followed by the upper left primary central incisor.

The most commonly observed traumatic injury was enamel fracture (39.4%), followed by discoloration of the crown (20.2%) (Fig. 2). Lateral luxation of the tooth was the most common luxation injury (9.8%), followed by loss of the tooth through avulsion (6.8%). The least frequent observations were the presence of infection in the labial sulcus (0.6%) and extrusive luxation (0.6%). In 22 teeth, a double trauma diagnosis was registered. The majority (20/22) consisted of a combination of crown discolouration and a luxation injury. The remaining two teeth had a fracture of the crown and a luxation injury. These teeth were registered according to the hierarchy above (Table 2).

The prevalence of trauma in the primary dentition as determined by the questionnaires, i.e., dental trauma remembered and reported by parents (11.66%) was lower than that found during the clinical examination (25.6%). Certain dental injuries were more likely to be remembered by the parents and acknowledged in the parental questionnaire. Avulsions were reported most reliably. Significant associations were also discovered between discolouration of the crown, enamel dentine fractures, lateral luxation, intrusive luxation and avulsion and the reporting of the injury by the parents. Enamel fractures were reported least frequently; only 16.26% of enamel fractures noted clinically were reported in the parental questionnaire.

Parents reported that most injuries occurred within and around the home, 46.9% and 35.7%. The majority of the parents reported that the dental injury was sustained as a result of a fall (66.3%), a bump with another child (17.3%) or a trip (9.2%).

No dental care was sought for 61% of children where trauma was reported in the questionnaire. Of those who sought care, the majority (55.3%) attended a dentist the same day of the accident. When subjected to analysis, no significant relationship was found between the different types of dental trauma and professional dental evaluation, i.e., the severity of the dental injury did not determine whether the child had a dental consultation following the traumatic incident, including the more severe dental injuries such as avulsions and intrusions.

Significant associations were established between dental trauma and increased overjet and anterior open bite (Table 3). Individual logistical regression analysis showed that the risk of dental trauma was three times greater with an increased overjet (> 6 mm) and two times greater with anterior open bite. In contrast, children with an overjet of < 3.5 mm were half as likely to suffer dental trauma (odds ratio, 0.52; confidence interval, 0.38; 0.71). Other potential factors such as gender or non-nutritive sucking habits were not significant in the logistic regression analysis (Table 3).

Each of the individual models was examined for significance, and only those factors of significance were carried forward to the final model (Table 4) revealing that the single most significant variable in predicting dental trauma in the primary dentition was an overjet > 6 mm (*P* value < 0.001).

The results of the questionnaire revealed that over half of the children had used a pacifier/soother (53.8%). A much smaller proportion of those questioned declared that their children had a history of digit sucking (9.8%)

Table 3. Individual logistic regression models

Variables	Dental trauma				
	Present *n* (%)	Absent *n* (%)	Total *n* (%)	Odds ratio (CI 95%)	*P*
Gender					
Male	112 (26.7)	309 (73.3)	421 (100)	1.09 (0.8, 1.48)	0.59
Female	103 (24.6)	315 (75.4)	418 (100)	0.92 (0.67,1.25)	0.52
Habits					
Pacifier	122 (27)	329 (73)	451 (100)	1.19 (0.87,1.63)	0.271
Digit	27 (33)	55 (67)	82 (100)	1.49 (0.91,2.42)	0.11
Horizontal Incisal relationships					
<3 mm	82 (19.5)	339 (80.5)	421 (100)	0.52 (0.38,0.71)	<0.001
3–6 mm	76 (27.4)	201 (72.6)	277 (100)	1.15 (0.83,1.59)	0.4
>6 mm	54 (46.1)	63 (53.9)	117 (100)	2.99 (2,4.47)	<0.001
Vertical Incisal relationships					
Positive overbite	160 (23.7)	515 (76.3)	675 (100)	0.62 (0.43,0.89)	0.03
Edge to edge	13 (23.6)	42 (76.4)	55 (100)	0.89 (0.47,1.7)	0.73
Anterior open bite	42 (38.5)	67 (61.5)	109 (100)	2.02 (1.32,3.08)	<0.001

Table 4. Final logistical regression model

	Odds ratio	95% CI	*P*
Overjet <3.5 mm	0.52	0.38–0.71	0.04
Overjet >6 mm	2.99	2–4.47	<0.001
Anterior open bite	2.02	1.32–3.08	0.22

and only 18 (2.1%) of the children had both habits. Parents/guardians were asked to estimate the duration of the non-nutritive habit in terms of both the hours per day (intensity) and months of use (duration) that their child was sucking their pacifier or digit. The mean number of hours per day was 6.4 h. The mean duration of digit habits was significantly longer at 36.6 months than that of pacifier habits (25.6 months).

Non-nutritive sucking habits were significantly associated with the development of both increased overjet and anterior open bite ($P > 0.001$). However, these habits were only significantly associated with dental trauma when adjusted for duration of the habit in months.

Discussion

This is the first time that dental trauma in the primary dentition has been examined in Ireland. A prevalence of 25.6% of dental trauma in the primary dentition was identified in this study. This compares well with recent cross-sectional studies that reported prevalence figures in excess of 35% using similar criteria (11, 22, 24). Differences in study design, inclusion and exclusion criteria, methodology, number and training of examiners and location, etc., may account for the range of prevalence data for injuries to the primary dentition (Table 1).

It is likely that the figure of 25.6% is an underrepresentation of the actual prevalence owing to the cross-sectional nature of the study; only injuries with signs present on the day of examination were registered. In cross-sectional surveys, certain oral injuries may not be evident at the time of examination, particularly injuries to the supporting tissues of teeth which are capable of healing without residual signs (32, 33). In addition, teeth were not scored as having sustained trauma if there was evidence of severe caries of the anterior teeth. The number of 5-year olds affected by caries in the anterior primary dentition in Ireland was found to be between 9.7% and 13.4% in a recent cross-sectional study (13).

In agreement with other studies (11, 23), the most common dental injuries noted in this study were the hard tissue injuries (56.49%); the majority of these were fractures of enamel (Fig. 2). Luxation injuries and injuries to the soft tissues are more commonly noted by others (34, 35). The difference in the relative frequency of individual injuries varies according to the methodology of the study. In cross-sectional studies, previous minor injuries to the dental soft tissues will go unreported (25). In contrast, the prospective and incidence studies record injuries only if the child is presented for treatment following the traumatic incident. This is more likely to occur following injuries to the soft tissues and more severe dental injuries. Crown discolouration in the absence of dental caries was noted in 20.5% of the children sampled. Discolouration of the crown is used as a marker of pulpal damage following previous luxation injury (36) in epidemiology studies where the use of special tests, such as radiographs and sensibility testing, is inappropriate.

The children sampled in this study were from an area of relatively low socio-economic status, although this parameter was not measured or analysed. Recent Brazilian cross-sectional studies have examined this variable (10, 11, 20, 22) with conflicting results, and it would be an interesting topic for further research.

Only 38.8% of the children whose parents recalled a dental injury had a dental examination following that injury. Over half attended on the day of the accident, with 34.2% attending within 1 week and the remainder (10.5%) within 1 month. Recent investigations reported that between 55% and 95% of dental trauma in this age group were not examined by a dentist (10, 11, 22). The authors theorised that lack of knowledge about the consequences of dental trauma in the primary dentition and a lack of access to dental services were the reasons

behind the neglect of these injuries. The importance placed on the primary dentition on the part of parents and guardians has been questioned as these teeth are eventually replaced (22).

In the current sample, a large proportion of the injuries noted were minor fractures of enamel (39.4%), and therefore, it is not surprising that dental care was not sought. In addition, the present study was carried out in an area of relatively low socio-economic status. Robson et al. (22) has previously reported an association between socio-economic status of the family and the act of seeking dental care for the child following dental injury. Although Irish children have access to free dental emergency care, knowledge of this service may be limited which coupled with a lack of importance placed on the primary dentition may account for the low level of treatment sought following traumatic injuries.

Children at a young age are subject to frequent falls, and parents may simply not be aware of the dental injury, especially if that injury was relatively minor. This is confirmed by the statistical analysis of the relationship between the individual injuries and parental recall in the questionnaire. The more severe dental injures, which were likely to have included bleeding and interference with occlusion, were significantly associated with parental recall (i.e. enamel dentine fracture, complicated crown fracture, lateral and intrusive luxation and avulsion).

The association between an increased overjet in the permanent dentition and an increased risk of dental trauma to the maxillary incisors has been established in various cross-sectional surveys (13) and confirmed in meta-analyses (28). Recent cross-sectional surveys have recognised a similar association in the primary dentition (22, 25, 29). The results from the present investigation confirm these findings that children with an increased overjet in the primary dentition are at three times greater risk of dental trauma in the primary dentition. In addition to increased overjet, the positive association between anterior open bite and dental trauma in the primary dentition has been examined in recent cross-sectional surveys (10, 25). In our sample, children with an anterior open bite were significantly more likely to experience dental trauma to their primary incisors.

No association was discovered between a history of a non-nutritive sucking habit and the occurrence of dental trauma. This lack of a direct association was confirmed through the logistical analysis and confirms the findings of Jorge et al. (11). However, in the current sample, when sucking habits were adjusted according to the duration of the habit, a significant association was discovered between the prevalence of dental trauma and the duration of the habit in months ($P < 0.001$).

Conclusion

Traumatic dental injuries occur frequently in children, with a prevalence of 25.6% of dental trauma in the primary dentition in Irish children. Surprisingly, there was a significant difference between the parental recall of a dental injury and the prevalence of signs of injury. Even when parents were aware of the dental injury, many children did not attend a dentist for evaluation. Non-nutritive habits are widespread and can cause increased overjet, anterior open bite which increased the risk of dental injury. Cessation of non-nutritive sucking habits before they exert an influence on the developing dentition should be encouraged. Given the consequences of dental injuries on both the child and the developing permanent successors, there is a need to educate parents, carers, teachers and dentists of the need for dental evaluation and treatment of injuries to the primary dentition.

References

1. Glendor U. Epidemiology of traumatic dental injuries – a 12 year review of the literature. Dent Traumatol 2008;24:603–11.
2. Tahmassebi JF, O'Sullivan EA. Diagnosis and management of trauma to primary dentition. Dent Update 1999;26:138–42.
3. Sennhenn-Kirchner S, Jacobs HG. Traumatic injuries to the primary dentition and effects on the permanent successors – a clinical follow-up study. Dent Traumatol 2006;22:237–41.
4. Lee JY, Divaris K. Hidden consequences of dental trauma: the social and psychological effects. Pediatr Dent 2009;31:96–101.
5. Fried I, Erickson P. Anterior tooth trauma in the primary dentition: incidence, classification, treatment methods, and sequelae: a review of the literature. ASDC J Dent Child 1995;62:256–61.
6. Townend E, Dimigen G, Fung D. A clinical study of child dental anxiety. Behav Res Ther 2000;38:31–46.
7. Davey GC. Dental phobias and anxieties: evidence for conditioning processes in the acquisition and modulation of a learned fear. Behav Res Ther 1989;27:51–8.
8. Flores MT, Malmgren B, Andersson L, Andreasen JO, Bakland LK, Barnett F et al. Guidelines for the management of traumatic dental injuries. III. Primary teeth. Dent Traumatol 2007;23:196–202.
9. Judd PL, Casas MJ. Psychosocial perceptions of premature tooth loss in children. Ont Dent 1995;72:16–8, 20, 22–3.
10. Oliveira LB, Marcenes W, Ardenghi TM, Sheiham A, Bönecker M. Traumatic dental injuries and associated factors among Brazilian preschool children. Dent Traumatol 2007;23:76–81.
11. Jorge KO, Moysés SJ, Ferreira e Ferreira E, Ramos-Jorge ML, de Araújo Zarzar PM. Prevalence and factors associated to dental trauma in infants 1–3 years of age. Dent Traumatol 2009;25:185–9.
12. Bastone EB, Freer TJ, McNamara JR. Epidemiology of dental trauma: a review of the literature. Aust Dent J 2000; 45:2–9.
13. Whelton H, Department of Health and Children, Northern Ireland Department of Health, Social Services and Public Safety. North South Survey of children's oral health in Ireland 2002: final report, December 2006. http://www.dohc.ie/publications/oral_health.html [last accessed on 26 January 2011].
14. 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.
15. Bijella MF, Yared FN, Bijella VT, Lopes ES. Occurrence of primary incisor traumatism in Brazilian children: a house-by-house survey. ASDC J Dent Child 1990;57:424–7.
16. Forsberg CM, Tedestam G. Traumatic injuries to teeth in Swedish children living in an urban area. Swed Dent J 1990;14:115–22.
17. Jones ML, Mourino AP, Bowden TA. Evaluation of occlusion, trauma, and dental anomalies in African-American children of metropolitan Headstart programs. J Clin Pediatr Dent 1993;18:51–4.

18. Jones SG, Nunn JH. The dental health of 3-year-old children in east Cumbria 1993. Community Dent Health 1995;12: 161–6.
19. Kramer PF, Zembruski C, Ferreira SH, Feldens CA. Traumatic dental injuries in Brazilian preschool children. Dent Traumatol 2003;19:299–303.
20. Granville-Garcia AF, de Menezes VA, de Lira PI. Dental trauma and associated factors in Brazilian preschoolers. Dent Traumatol 2006;22:318–22.
21. Rodríguez JG. Traumatic anterior dental injuries in Cuban preschool children. Dent Traumatol 2007;23:241–2.
22. Robson F, Ramos-Jorge ML, Bendo CB, Vale MP, Paiva SM, Pordeus IA. Prevalence and determining factors of traumatic injuries to primary teeth in preschool children. Dent Traumatol 2009;25:118–22.
23. Ferreira JM, Fernandes de Andrade EM, Catz CR, Rosenblatt A. Prevalence of dental trauma in deciduous teeth of Brazilian children. Dental Traumatol 2009;25:219–23.
24. Wendt FP, Torriani DD, Assunção MC, Romano AR, Bonow ML, da Costa CT et al. Traumatic dental injuries in primary dentition: epidemiological study among preschool children in South Brazil. Dent Traumatol 2010;26:168–75.
25. Feldens CA, Kramer PF, Ferreira SH, Spiguel MH, Marquezan M. Exploring factors associated with traumatic dental injuries in preschool children: a Poisson regression analysis. Dent Traumatol 2010;26:143–8.
26. Adair SM. Pacifier use in children: a review of recent literature. Pediatr Dent 2003;25:449–58.
27. Warren JJ, Slayton RL, Bishara SE, Levy SM, Yonezu T, Kanellis MJ. Effects of nonnutritive sucking habits on occlusal characteristics in the mixed dentition. Pediatr Dent 2005;27: 445–50.
28. Nuygen QV, Bezemer PD, Habets L, Prahl-Andersen B. A systematic review of the relationship between overjet size and traumatic dental injuries. Eur J Orthod 1999;21:503–15.
29. de Vasconcelos Cunha Bonini GA, Marcenes W, Oliveira LB, Sheiham A, Bönecker M. Trends in the prevalence of traumatic dental injuries in Brazilian preschool children. Dent Traumatol 2009;25:594–8.
30. Andreasen JO, Andreasen FM, Bakland LK, Flores MT. Traumatic dental injuries – a manual, 4th edn. Copenhagen: Blackwell Munksgaard; 2007.
31. von Arx T. Developmental disturbances of permanent teeth following trauma to the primary dentition. Aust Dent J 1993;38:1–10.
32. Feliciano KM, de Franca Caldas A Jr. A systematic review of the diagnostic classifications of traumatic dental injuries. Dent Traumatol 2006;22:71–6.
33. Beltrão EM, Cavalcanti AL, Albuquerque SS, Duarte RC. Prevalence of dental trauma children aged 1–3 years in Joao Pessoa (Brazil). Eur Arch Paediatr Dent 2007;8:141–3.
34. Skaare AB, Jacobsen I. Primary tooth injuries in Norwegian children (1–8 years). Dent Traumatol 2005;21:315–9.
35. Choi SC, Park JH, Pae A, Kim JR. Retrospective study on traumatic dental injuries in preschool children at Kyung Hee Dental Hospital, Seoul, South Korea. Dent Traumatol 2010;26:70–5.
36. Fried I, Erickson P, Schwartz S, Keenan K. Subluxation injuries of maxillary primary anterior teeth: epidemiology and prognosis of 207 traumatized teeth. Pediatr Dent 1996;18:145–51.
37. Cunha RF, Pugliesi DM, de Mello Vieira AE. Oral trauma in Brazilian patients aged 0–3 years. Dent Traumatol 2001;17: 210–2.