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Combined effect of anterior malocclusion and inadequate lip coverage on dental trauma in primary teeth

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Abstract – *Objectives*: The main objective of this study was to investigate whether the interaction of malocclusion (open bite or increased overjet) combined with inadequate lip coverage strengthens its association with traumatic dental injury (TDI) in the primary teeth of preschool children compared to the presence of malocclusion alone. *Subjects and methods*: A cross-sectional survey was conducted with 376 children aged 36–59 months who attended the National Day of Children's Vaccination. Presence of TDI, tooth discoloration, and sinus tract were evaluated in the children. Variables associated with occlusion were also evaluated. A Poisson regression analysis was performed to verify the association between the explanatory variables and TDI as well as possible interactions among the variables. Then, the prevalence ratio was calculated. *Results*: The prevalence of TDI was 27.7%. The maxillary central incisor was the most affected tooth, without differences between the right and left sides. Boys had more dental trauma than girls ($P = 0.04$). The most common TDI was crown fracture restricted to the enamel (58.4%). Children with a combination of anterior open bite or increased overjet and inadequate lip coverage presented a higher prevalence of TDI than when the malocclusions were presented alone ($P < 0.05$). The same trends were observed when we included, in the final adjusted model, increased overjet instead of open bite. *Conclusions*: Anterior malocclusions of primary teeth such as increased overjet and anterior open bite are statistically significantly associated with dental trauma only when inadequate lip coverage is also present.

Introduction

A high prevalence of traumatic dental injury (TDI) has been reported in many countries. Oral trauma among preschool children is a relatively under-researched issue when compared to the vast number of publications concerning dental trauma in school-age children (1–4). Nonetheless, previous studies have demonstrated that about one-third of these preschoolers suffer TDI (5). Among all facial injuries, dental injuries are the most common in children (1, 2, 6–8). In Brazil, the prevalence of TDI in preschool children ranged from 9.4% (9) to 36.6% (10) and has been shown to be increasing among Brazilian preschool children (11).

Evaluation of TDI in primary teeth is especially important because of the potential for periapical sequelae, which can adversely affect the development of permanent teeth and the developing occlusion (12). The identification of associated factors which predispose to TDI is also relevant as it may permit the adoption of preventive measures.

The association between anterior open bite and TDI in permanent dentition has been consistently shown in the literature (1, 2, 4, 13–16). However, studies have considered mostly the malocclusion alone (anterior open bite or increased overjet), and the combined presence with inadequate lip coverage has not been taken into account (1–4, 9–11, 17–19). A previous study has found that patients with inadequate lip coverage associated with increased overjet presented significantly more teeth involved with TDI (20). Nevertheless, to the best of our knowledge, no study has been conducted to verify the influence of the interaction between inadequate lip coverage and malocclusions on TDI in primary dentition.

The presence of adequate lip coverage independent of the malocclusion could protect the anterior teeth from the impact, and therefore, children with anterior malocclusion combined with the presence of inadequate lip coverage would have stronger association with TDI than children with malocclusion alone. This hypothesis, however, has not been tested yet.

Thus, the aim of this study was to investigate whether the interaction of malocclusions (open bite or increased overjet) combined with inadequate lip coverage strengthens the association with TDI compared to the presence of malocclusion alone in primary teeth of preschool children aged 36–59 months, living in Amparo, Brazil.

Material and methods

The research protocol related to this epidemiological survey was previously approved by the Ethics Committee of our Dental School, University of São Paulo. For sample size calculation, we assumed TDI prevalence of 25%, a standard error of 4%, and a confidence level of 90%. A minimum sample size of 317 children was predicted, and 380 children were invited to participate, considering a minimum response rate of 80%. A total of 376 children of 3–4 years of age of both genders were examined for this cross-sectional study (positive response rate of 98.9%). Written consent for participating in the survey was obtained from the children's legal guardians. A systematic sampling procedure was used to select the sample.

Participants were randomly selected, using a table of random numbers, in 11 health centers during the National Day of Children's Vaccination carried out in the city of Amparo, São Paulo, Brazil (uptake rate > 95%), applying a previously used method (9, 11). Health centers were used as sampling units because the city is administratively divided into regions, and each one has a public health center that is responsible for the people who live in each area. The sample was stratified according to the number of children who had attended each health center in the previous year. To avoid selection bias, relatives were excluded. This random process was the same for all health centers.

Eleven dentists previously trained by two researchers carried out clinical examinations for recording dental trauma and presence of malocclusions. Theoretical and clinical training as well as exercises was arranged for a total of 12 h (11). However, the inter-examiner reliability was not assessed.

The dental examination for TDIs was carried out only for anterior primary teeth. The criteria used to assess TDIs were derived from a modified version of Andreasen's classification (21), which includes fracture of the crown involving the enamel only, fracture of the crown involving enamel and dentin, fracture of the crown involving the pulp, tooth missing owing to trauma, and also presence of tooth discoloration. The examiner was orientated to check the tooth color by comparing it with the other teeth of the same child. If an evident change in the normal color of a tooth had been observed, this tooth would be considered to have tooth discoloration. With regard to the tooth missing, this tooth was considered as missing because of the traumatic injury only if the child did not present carious teeth in other anterior teeth.

Root fractures and pulp status defined by Andreasen's classification were not recorded in this study because dental radiographs or pulp tests are not appropriate for epidemiological surveys (22). Nevertheless, the problem of pulp sensibility testing in our epidemiological survey was minimized by assessing pulp involvement through the presence of discoloration and the presence of a sinus tract without signs of caries; these data were added to the criteria used to assess TDI.

Overjet was calculated from the labial surface of the lower primary incisor to the incisal edge of the most prominent upper primary incisor. This distance was measured with the aid of an WHO probe. When the distance measured was between 0 and 3.0 mm, we classified this as absence of increased overjet. If this distance was over 3.0 mm, the patient was classified as having increased overjet (19, 20). The lack of vertical overlap of any incisor in the occlusal position was classified as anterior open bite.

Lip coverage was appraised with the lip in a relaxed condition. If the upper lip completely covered the crowns of the upper primary incisors, the lip coverage was classified as adequate. On the other hand, if any portion of the crown was visible when the lips were in a relaxed position, the lip coverage was considered inadequate (19, 20).

During the survey, children were examined while seated on a dental chair under a standard conventional dental light. Before the clinical examination, wet gauze pads were used to clean the tooth surfaces (11), and visual examination with a plane dental mirror was conducted. For data analysis, firstly, the prevalence and proportion of each type of TDI were calculated. The association between subject variables and the presence of TDI was assessed. The independent variables evaluated were gender, age (3 and 4 years), presence of anterior open bite (no or yes), inadequate lip coverage (no or yes), and increased overjet (no or yes). The outcome was dichotomized in terms of the absence or presence of TDI. The prevalence ratio (PR), 95% confidence interval (95% CI), and significance level were calculated for each variable by univariate Poisson regression with robust variance. This approach is considered more appropriate for use in cross-sectional studies than is logistic regression, as the odds ratios usually overestimate the PRs, and the former is more difficult for non-specialists to comprehend (23).

Afterward, a multiple Poisson analysis was performed. A level of 20% significance obtained in univariate analysis was considered for entry of the variable in the model, and 5% level of significance was chosen to keep the variable in the adjusted model. For the analyses, statistical software was employed (Stata 8.0; Stata Corp., College Station, USA).

Results

Of the 376 children, 104 (27.7%) had some type of TDI. The most common TDI was crown fracture restricted to the enamel (58.4%), followed by tooth discoloration (18.4%); crown fracture of the enamel and dentin (17.6%); and crown fracture of the enamel, dentin, and pulp (0.8%). Other findings related to TDI were sinus tract without signs of caries (3.2%) and missing teeth owing to trauma (1.6%).

Boys presented significantly more TDI than girls ($P = 0.04$). Children with malocclusions (anterior open bite and increased overjet) as well as inadequate lip coverage had a higher prevalence of TDI than their counterparts with normal occlusion ($P < 0.05$). There were no significant differences in TDI prevalence between 3- and 4-year-old children ($P > 0.05$). Table 1 presents the PR of variables tested with TDI.

The multiple regression analysis showed statistically significant associations between both types of malocclusions (anterior open bite and increased overjet) and inadequate lip coverage. However, when the three variables were added to the model, they lost significance. We opted to develop two different adjusted models (Tables 2 and 3). The first regression model was used to evaluate the interaction between inadequate lip coverage and increased overjet (Table 2), and the second adjusted model evaluated inadequate lip coverage and open bite (Table 3). In both these final models, the association between inadequate lip coverage and anterior open bite or increased overjet showed a higher prevalence of TDI compared to the prevalence of TDI with malocclusions alone (Tables 2 and 3). However, the association of TDI with malocclusions alone lost statistical significance in the final analysis.

Discussion

TDI in children very often causes aesthetic, psychological, social, and therapeutic problems. Further, most teeth with TDI had been untreated (9). Considerably, more efforts in health promotion policies are required to encourage the implementation of preventive strategies to reduce the frequency of TDI in preschool children. Such strategies could impact favorably on the consequences of injuries to primary teeth on overall health, especially for permanent successors.

In the present study, fractures restricted to the enamel were the most prevalent type of TDI. This occurrence is relatively common in cross-sectional surveys, as the luxations are usually underestimated using this methodology. Resilience of the periodontal structures appears to be the most significant factor in determining the extent of injuries. Thus, impact in the very resilient skeleton supporting the primary dentition usually results in tooth displacement rather than fracture of hard tissues (6).

Table 1. Prevalence ratio (PR) values with 95% confidence interval (95% CI) obtained by Poisson regression using subjects with traumatic dental injuries (TDIs) as the outcome

Explanatory variables	*N* (total)	*N* with TDI (%)	PR	95% CI	*P**
Gender					
Male	185	60 (32.4)	1.00		**0.040**
Female	191	44 (23.0)	0.71	0.51–0.99	
Age (years old)					
Three	184	49 (26.6)	1.00		**0.640**
Four	192	55 (28.8)	1.08	0.78–1.50	
Anterior open bite					
No	237	56 (23.7)	1.00		**0.023**
Yes	139	48 (34.5)	1.46	1.05–2.01	
Inadequate lip coverage					
No	283	68 (24.0)	1.00		**0.005**
Yes	93	36 (38.7)	1.60	1.15–2.23	
Increased overjet					
No	294	70 (23.9)	1.00		**0.001**
Yes	82	34 (41.5)	1.74	1.25–2.41	

*Evaluated by Wald test.
The values in bold shows de level of significance of each variable in the multiple model.

Table 2. Multiple Poisson regression for some subject variables in children with traumatic dental injuries (TDIs) considering the association between inadequate lip coverage and increased overjet

Explanatory variables	PR	95% CI	*P*
Gender			
Male	1.00		**0.030**
Female	0.70	0.51–0.97	
Adequate lip coverage and absence of increased overjet			
Reference	1.00		
Inadequate lip coverage alone			
Yes	0.78	0.37–1.67	**0.546**
Increased overjet alone			
Yes	0.64	0.28–1.46	**0.292**
Inadequate lip coverage plus increased overjet			
Yes	2.43	1.68–3.53	**<0.001**

PR, Prevalence ratio; 95% CI, 95% confidence interval.
The values in bold shows the level of significance of each variable in the multiple model.

Table 3. Multiple Poisson regression for some subject variables in children with traumatic dental injuries (TDIs) considering the association between inadequate lip coverage and anterior open bite

Explanatory variables	PR	95% CI	*P*
Gender			
Male	1.00		**0.032**
Female	0.66	0.45–0.96	
Adequate lip coverage and absence of anterior open bite			
Reference	1.00		
Inadequate lip coverage alone			
Yes	1.18	0.55–2.51	**0.671**
Anterior open bite alone			
Yes	1.12	0.68–1.86	**0.654**
Inadequate lip coverage plus anterior open bite			
Yes	2.15	1.42–3.25	**<0.001**

PR, Prevalence ratio; 95% CI, 95% confidence interval.
The values in bold shows the level of significance of each variable in the multiple model.

These injuries cannot be identified in cross-sectional studies. Furthermore, fractures restricted to the enamel can also be associated with luxations and subluxations. This fact can be considered a limitation of our study as these possibilities were not evaluated. Although fractures restricted to the enamel do not require any therapeutic approach, other possible associated TDIs can lead to sequelae in the traumatized primary teeth or in the successor teeth.

Previous studies suggest that in younger children, open bite and increased overjet are important predisposing factors for injuries to primary incisors (1, 2, 9, 11, 17, 18). The present study contributes to the elucidation of inadequate lip coverage as an important factor associated with TDIs. Children with malocclusions such as open bite or increased overjet presented with inadequate lip coverage had a higher prevalence of TDI compared to those with adequate lip coverage. Additionally, this

study also showed an association between TDIs in primary teeth and inadequate lip coverage. Children with inadequate lip coverage presented a greater risk of traumatic injuries to the primary incisors. On the other hand, when the multiple regression analyses were performed, the anterior malocclusions alone as well as only inadequate lip coverage were not associated with TDI. However, when one type of malocclusion was present together with inadequate lip coverage, the association with TDI was stronger. Although the relationship between the type of malocclusion and inadequate lip coverage has been extensively described, these conditions can occur independently. Indeed, in our sample, 18% of the children presented open bite without inadequate lip coverage. A similar situation (10%) was observed among children with increased overjet. The multiple models contributed to explain the interaction between malocclusions and inadequate lip coverage when associated with TDI. This is the first study that has observed the effect of this interaction.

A possible explanation for these findings could be that the lips can partly absorb the impact applied on anterior teeth when the child suffered a trauma. When children present anterior malocclusion but the lip coverage is adequate, the TDI could be less frequent owing to protection of the lip. Therefore, anterior malocclusion but with adequate lip coverage could not be considered a risk indicator of TDI. This is a new and significant finding of our study. However, this result should be interpreted within the limitation of a cross-sectional study. This association between anterior malocclusion and inadequate lip coverage should be investigated further using a cohort design.

In conclusion, anterior malocclusions of primary teeth such as increased overjet and anterior open bite are significantly associated with dental trauma only when inadequate lip coverage is also present. The presence of the malocclusions with adequate lip coverage is not an important risk indicator, and therefore, the studies about TDI should consider the combined effect of these disorders.

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References

1. Borzabadi-Farahani A, Eslamipour F. An investigation into the association between facial profile and maxillary incisor trauma, a clinical non-radiographic study. Dent Traumatol 2010;26:311–16.
2. Brin I, Ben-Bassat Y, Heling I, Brezniak N. Profile of an orthodontic patient at risk of dental trauma. Endod Dent Traumatol 2000;16:111–5.
3. Koroluk LD, Tulloch JF, Phillips C. Incisor trauma and early treatment for class ii division 1 malocclusion. Am J Orthod Dentofacial Orthop 2003;123:117–26.
4. Shulman JD, Peterson J. The association between incisor trauma and occlusal characteristics in individuals 8–50 years of age. Dent Traumatol 2004;20:67–74.
5. Granville-Garcia AF, de Menezes VA, de Lira PI. Dental trauma and associated factors in brazilian preschoolers. Dent Traumatol 2006;22:318–22.
6. Andreasen FM, Andreasen JO, Tsukiboshi M Examination and diagnosis of dental injuries. In: Andreasen JO, Andreasen FM, Andersson L, editors. Textbook and atlas of traumatic injuries to the teeth, 4th edn. Oxford: Blackwell Munksgaard; 2007. p. 255–79.
7. 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.
8. Glendor U, Halling A, Andersson L, Eilert-Petersson E. Incidence of traumatic tooth injuries in children and adolescents in the county of vastmanland, sweden. Swed Dent J 1996;20:15–28.
9. Oliveira LB, Marcenes W, Ardenghi TM, Sheiham A, Bonecker M. Traumatic dental injuries and associated factors among brazilian preschool children. Dent Traumatol 2007;23:76–81.
10. Wendt FP, Torriani DD, Assuncao 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;26:168–73.
11. de Vasconcelos Cunha Bonini GA, Marcenes W, Oliveira LB, Sheiham A, Bonecker M. Trends in the prevalence of traumatic dental injuries in brazilian preschool children. Dent Traumatol 2009;25:594–8.
12. 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.
13. Nguyen 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.
14. Petti S, Cairella G, Tarsitani G. Childhood obesity: a risk factor for traumatic injuries to anterior teeth. Endod Dent Traumatol 1997;13:285–8.
15. Petti S, Tarsitani G. Traumatic injuries to anterior teeth in italian schoolchildren: prevalence and risk factors. Endod Dent Traumatol 1996;12:294–7.
16. Soriano EP, Caldas AF Jr, Goes PS. Risk factors related to traumatic dental injuries in brazilian schoolchildren. Dent Traumatol 2004;20:246–50.
17. Viegas CM, Scarpelli AC, Carvalho AC, Ferreira FM, Pordeus IA, Paiva SM. Predisposing factors for traumatic dental injuries in brazilian preschool children. Eur J Paediatr Dent 2010;11: 59–65.
18. 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.
19. Burden DJ. An investigation of the association between overjet size, lip coverage, and traumatic injury to maxillary incisors. Eur J Orthod 1995;17:513–7.
20. Bauss O, Freitag S, Rohling J, Rahman A. Influence of overjet and lip coverage on the prevalence and severity of incisor trauma. J Orofac Orthop 2008;69:402–10.
21. Glendor U, Marcenes W, Andreasen JO Classification, epidemiology and etiology. In: Andreasen JO, Andreasen FM, Andersson L, editors. Textbook and atlas of traumatic injuries to the teeth, 4th edn. Oxford: Blackwell Munksgaard; 2007. p. 217–54.
22. Feliciano KM, de Franca Caldas A Jr. A systematic review of the diagnostic classifications of traumatic dental injuries. Dent Traumatol 2006;22:71–6.
23. Barros AJ, Hirakata VN. Alternatives for logistic regression in cross-sectional studies: an empirical comparison of models that directly estimate the prevalence ratio. BMC Med Res Methodol 2003;3:21.