


The effect of enamel fractures on oral health-related quality of life in adolescents

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Abstract

Background/Aim: Enamel fractures are the most common type of traumatic dental injury (TDI) in children and adolescents. Recognizing the impact of these fractures on oral health-related quality of life (OHRQoL) could contribute to the establishment of treatment protocols. The aim of this study was to assess and quantify the impact of enamel fractures on overall OHRQoL and domain scores in adolescents.

Materials and Methods: A cross-sectional study was conducted with 775 adolescents aged 11 to 14 years in the city of Santo Ângelo in southern Brazil. Sociodemographic variables were collected from parents/caregivers using a structured questionnaire. The adolescents answered the Child Perceptions Questionnaire (CPQ₁₁₋₁₄). Physical examinations were performed by an examiner who had undergone training and calibration exercises for the investigation of TDI (Andreasen criteria), dental caries (WHO criteria), and malocclusion (Dental Aesthetic Index). Data analysis involved Poisson regression with robust variance.

Results: The prevalence of TDI was 11.9% and enamel fractures accounted for 79.3% of all injuries. In the multivariate analysis, adolescents with enamel fractures had 29% higher CPQ₁₁₋₁₄ scores (worse OHRQoL) than those without TDI, even after adjustment for sociodemographic and clinical variables (mean ratio = 1.29; 95% CI: 1.09-1.53; *P* = .003). Enamel fractures exerted a negative impact on the functional limitation, emotional well-being, and social well-being domains.

Conclusions: Enamel fractures exert a negative impact on the OHRQoL of adolescents, suggesting that subjective measures should be incorporated in the evaluation of patients with this traumatic injury.

KEYWORDS

adolescent, quality of life, tooth injuries

1 | INTRODUCTION

Evidence-based treatment decisions in dental traumatology should take into consideration all possible outcomes reported in clinical studies.¹ There is a growing consensus that outcomes need to be

relevant not only to clinicians and policymakers, but especially to patients.² The International Association of Dental Traumatology (IADT) recently recognized that patient-related outcomes were poorly represented in the dental trauma literature and defined oral health-related quality of life (OHRQoL) as an important outcome to be investigated.¹

Individual studies and systematic reviews generally suggest that a traumatic dental injury (TDI) exerts an impact on the OHRQoL of children and adolescents.³⁻⁵ However, TDI includes a variety of tooth injuries with potentially different degrees of impact. It is plausible that greater impact occurs with injuries that involve exposure of the pulp and/or luxation of the tooth.⁴ Decision making with regard to the most effective treatment, including the need to treat a TDI or its consequences, should be based on the possible effects on the quality of life of each particular injury.

Enamel fractures are among the most common types of TDI in children and adolescents.⁶⁻⁹ The treatment proposed by the International Association of Dental Traumatology and the Dental Trauma Guide for permanent teeth includes bonding of the tooth fragment, contouring or restoration with composite resin depending on the extent and location of the fracture.^{10,11} However, the evidence demonstrates that the risk of pulp necrosis and infection of the root canal system, infection-related (inflammatory) resorption or any other relevant complication is very low with this type of TDI.^{11,12} Thus, the evaluation of the negative impact of an enamel fracture on OHRQoL may provide more significant information to consider when deciding whether to treat this type of TDI. Enamel fractures in the primary dentition seem not to have a negative impact on OHRQoL.¹³ However, few studies have investigated the impact of enamel fractures in the permanent dentition on OHRQoL and, to the best of the authors' knowledge, no studies have examined this issue in adolescents, who constitute a large portion of the population affected by this type of TDI.

Thus, the aim of this study was to assess and quantify the impact of enamel fractures in permanent teeth on overall OHRQoL and domain scores among adolescents living in southern Brazil.

2 | MATERIALS AND METHODS

The present cross-sectional study was part of a comprehensive oral health survey carried out in the city of Santo Ângelo in southern Brazil, which has an estimated population of 76 304. The source population comprised 3290 adolescents aged 11 to 14 years enrolled in the public-school system, representing approximately 70% of the population in this age range. Students with a history of orthodontic treatment and those who were not intellectually capable of answering the questionnaire were excluded from the study.

Three sample size calculations were performed to estimate the effect of malocclusion, dental caries, and TDI on OHRQoL, opting for the condition that required the largest sample size. Considering a mean (\pm standard deviation) CPQ₁₁₋₁₄ score of 11.98 (\pm 8.48) among non-exposed individuals and 13.98 (\pm 8.77) among exposed individuals,¹⁴ the minimum sample was determined to be 460 adolescents. A correction factor of 1.3 (design effect) was applied to increase the precision of the study due to the cluster sampling method, determining a minimum sample of 598 adolescents, to which 20% was added due to the multivariate analysis, leading to a total of 718 adolescents.

A single-stage cluster sampling strategy was adopted, with each school corresponding to one cluster. The 33 public schools were first categorized based on location (urban or rural area), type of school (state-run or municipal), and size (municipal schools stratified by quartiles and state-run schools stratified by quintiles according to the number of students enrolled). To reach the required sample size and to obtain a representative sample, 11 schools were randomly selected proportional to the strata. Four municipal schools (one from each quartile) and five state-run schools (one from each quintile) were selected from the urban area. One municipal school and one state-run school were selected from the rural area. Thus, the sample had virtually the same proportion of adolescents enrolled in municipal and state-run public schools in the urban areas (34.7% and 57.7%, respectively) and rural areas (3.6% and 4.0%, respectively).

Parents/caregivers answered a structured questionnaire addressing the adolescent's gender and age, family structure, mother's schooling, and family income. Family structure was dichotomized as nuclear (adolescent lives with both parents) or non-nuclear (adolescent lives with only one or neither parent). Mother's schooling was recorded in years of formal education and categorized as <8, 8-10, and \geq 11. Family income was measured quantitatively as the total income of the household in the previous month and stratified in terciles.

OHRQoL was measured using the Brazilian version of the CPQ₁₁₋₁₄ - Impact Short Form 16, which comprises 16 items distributed among four subscales: oral symptoms, functional limitations, social well-being, and emotional well-being. The answers indicate the frequency with which events regarding the teeth, lips, jaws, and mouth occurred in the previous three months. Each item has five response options scored on a scale of 0 to 4. The overall CPQ₁₁₋₁₄ score ranges from 0 to 64, with higher scores denoting a poorer quality of life. The CPQ₁₁₋₁₄ has been validated for use on Brazilian adolescents and has good psychometric properties.¹⁵ In the present study, the CPQ₁₁₋₁₄ was self-administered by the respondents at school.

The adolescents were examined clinically by a single examiner who had previously undergone training and calibration exercises. The examinations were performed in a classroom with good natural lighting with the aid of flat dental mirrors, millimeter probes, and wooden tongue depressors. The calibration process was conducted with a group of 30 adolescents aged 11 to 14 years who did not participate in the main study. The weighted kappa coefficient for intra-examiner agreement was 0.74, 1.0, and 0.97 for dental caries, TDI, and malocclusion, respectively.

The criteria of the World Health Organization¹⁶ were used for the determination of dental caries experience. The number of decayed, missing and filled teeth (DMFT index) was recorded, and untreated caries was dichotomized as yes (D component \geq 1) or absent (D component = 0). TDI was assessed using the classification proposed by Andreasen¹⁷ and subsequently dichotomized as present or absent. Malocclusion was classified using the Dental Aesthetic Index (DAI)¹⁶ and categorized a normal, definite, or severe/handicapping.

Data analysis was performed using the Statistical Package for the Social Sciences (SPSS, version 16.0, 2007; SPSS Inc). CPQ₁₁₋₁₄ scores were compared between the categories of TDI and the demographic, socioeconomic and clinical adjustment variables using the Mann-Whitney and Kruskal-Wallis tests, considering the slightly asymmetrical distribution of the outcome. Poisson regression with robust variance was performed to compare CPQ₁₁₋₁₄ scores between adolescents with enamel fracture and without TDI, as well as between categories of the other independent variables. In the multivariate model, mean ratios (MR) were adjusted for demographic, socioeconomic and clinical variables that remained in the final model. Variables with a *P*-value < .20 in the adjusted assessment were maintained in the final regression model. Finally, the Mann-Whitney test was used to estimate the impact of TDI as a whole and enamel fracture on the overall CPQ₁₁₋₁₄ and individual domain scores.

This study received approval from the Human Research Ethics Committee of the Lutheran University of Brazil (certificate number: 30660314.9.00000.5349). Informed consent was obtained from parents/caregivers of the children prior to the onset of the data collection.

3 | RESULTS

The final sample comprised 775 adolescents aged 11 to 14 years. Mean [\pm standard deviation (SD)] age was 12.2 (\pm 1.1) years. Mother's schooling ranged from 0 to 16 years [mean: 8.0 (\pm 3.4) years]. The majority of adolescents lived in nuclear families, with 60% earning an income less than two times the Brazilian monthly minimum wage. The prevalence of TDI was 11.9% (92/775) and enamel fractures accounted for 79.3% of the injuries (73/92). The prevalence of the other clinical conditions was 17.3% for untreated dental caries, 17.1% for definite malocclusion, and 10.5% for severe malocclusion (Table 1).

CPQ₁₁₋₁₄ scores ranged from 0 to 52 [mean (\pm SD): 10.9 (\pm 8.8)]. For the oral symptoms, functional limitations, emotional well-being, and social well-being domains, mean (\pm SD) scores were respectively 3.8 (\pm 2.7), 2.4 (\pm 2.6), 2.8 (\pm 3.5), and 1.7 (\pm 2.4). Adolescents with enamel fracture and other TDI had worse OHRQoL scores compared to those without TDI. Moreover, CPQ₁₁₋₁₄ scores were significantly higher among girls (*P* = .001) and younger adolescents (*P* = .015).

The multivariate regression analyses (Table 2) revealed that adolescents with enamel fractures had 29% higher CPQ₁₁₋₁₄ scores compared to those without TDI, even after adjusting for demographic, socioeconomic, and clinical variables (MR = 1.29; 95% CI: 1.09 to 1.53). Although participants with other TDI also had higher OHRQoL scores than those without TDI, the small sample size in this category (*n* = 19) determined a wide 95% CI in the regression analysis and prevented the detection of statistical significance. Furthermore, significantly higher CPQ₁₁₋₁₄ scores were found in female adolescents (*P* < .001) as well as adolescents whose mothers had a lower level of schooling (*P* = .020).

The following quality of life domains were negatively affected among the individuals with TDI: functional limitation (*P* = .006),

TABLE 1 Characteristics associated with CPQ₁₁₋₁₄ scores in adolescents

Variables	N (%)	CPQ ₁₁₋₁₄	
		Mean (SD)	<i>P</i> *
Gender			
Male	375 (48.4)	9.68 (7.71)	.001
Female	400 (51.6)	11.79 (9.11)	
Age (y)			
11	259 (33.4)	11.51 (8.96)	.015
12	205 (26.5)	11.21 (7.99)	
13	165 (21.3)	9.97 (8.34)	
14	146 (18.8)	9.73 (8.57)	
Mother's schooling (y)			
<8	334 (43.5)	11.29 (8.60)	.069
8-10	196 (25.5)	11.28 (9.43)	
\geq 11	238 (31.0)	9.58 (7.57)	
Family income (terciles)			
1 (poorest)	240 (33.5)	11.22 (9.06)	.804
2	241 (33.6)	10.45 (7.87)	
3 (richest)	236 (32.9)	10.80 (8.96)	
Family structure			
Nuclear	487 (63.2)	10.84 (8.52)	.636
Non-nuclear	284 (36.8)	10.59 (8.54)	
Malocclusion			
Normal	561 (72.5)	10.47 (8.40)	.075
Definite	132 (17.1)	11.18 (9.10)	
Severe/ Handicapping	81 (10.5)	12.31 (8.33)	
Untreated dental caries			
Yes	134 (17.3)	11.98 (9.16)	.086
No	641 (82.7)	10.52 (8.37)	
Traumatic dental injury			
No	683 (88.1)	10.45 (8.33)	.028
Enamel fracture	73 (9.4)	13.21 (9.21)	
Other TDI	19 (2.5)	13.00 (11.04)	

**P*: Mann-Whitney or Kruskal-Wallis tests.

emotional well-being (*P* = .003), and social well-being (*P* = .014). Enamel fracture also exerted a significant effect on the functional limitation (*P* = .014), emotional well-being (*P* = .004), and social well-being (*P* = .012) domains. The same domains were negatively affected among adolescents with other types of TDI. The oral symptoms domain was not affected in adolescents with TDI or those with enamel fracture (Table 3).

4 | DISCUSSION

The present study investigated the impact of enamel fractures on OHRQoL among adolescents. The main finding was that enamel

	Crude		Adjusted ^a	
	MR ^b (95% CI)	P-value	MR (95% CI)	P-value
Gender				
Male	1.00	.001	1.00	<.001
Female	1.20 (1.07-1.34)		1.26 (1.12-1.40)	
Age (y)				
11	1.20 (1.01-1.43)	.121	1.21 (1.01-1.43)	.093
12	1.19 (1.00-1.41)		1.14 (0.96-1.35)	
13	1.05 (0.86-1.27)		1.03 (0.86-1.24)	
14	1.00		1.00	
Mother's schooling (y)				
<8	1.16 (1.01-1.32)	.027	1.21 (1.06-1.37)	.007
8-10	1.16 (0.99-1.35)		1.22 (1.05-1.42)	
≥11	1.00		1.00	
Family income (terciles)				
1 (poorest)	1.02 (0.88-1.19)	.600		
2	0.96 (0.84-1.11)		^b	
3 (richest)	1.00			
Family structure				
Nuclear	1.05 (0.94-1.18)	.687	^b	
Non-nuclear	1.00			
Malocclusion				
Normal	1.00	.127	1.00	.097
Definite	1.05 (0.90-1.22)		1.10 (0.95-1.27)	
Severe/ Handicapping	1.16 (0.98-1.36)		1.18 (1.00-1.39)	
Untreated dental caries				
Yes	1.16 (1.00-1.34)	.054	1.10 (0.95-1.28)	.193
No	1.00		1.00	
Traumatic dental injury				
Enamel fracture	1.26 (1.07-1.50)	.007	1.29 (1.09-1.53)	.003
Other TDI	1.25 (0.85-1.81)	.256	1.22 (0.84-1.78)	.297
Without TDI	1.00		1.00	

Abbreviation: MR, mean ratio.

^aResults adjusted for demographic, socioeconomic, and clinical variables of the final model.

^bVariables that did not remain in the final model.

TABLE 2 Crude and adjusted mean ratios (MR) of associations between CPQ₁₁₋₁₄ scores, Traumatic Dental Injuries, and confounding variables

fractures exert a negative impact on OHRQoL independently of demographic, socioeconomic and clinical characteristics. The domains affected by enamel fractures were functional limitation, emotional well-being and social well-being, whereas no negative impact was found regarding oral symptoms.

Exploring clinically relevant outcomes is critical when identifying priorities in public health and studies that investigate the impact of adverse oral conditions on OHRQoL are fundamental.¹⁸ Previous studies with different populations report that TDI exerts a negative on OHRQoL,³⁻⁵ but no studies investigated the impact of enamel fracture alone on this outcome in adolescents. A previous study involving Brazilian children aged eight to ten years

found no negative impact from enamel fractures.¹⁹ It is possible that children in this age group are less concerned with the domains in which impact was detected in the present investigation, especially emotional and social well-being. Older adolescents seem to experience greater impact on their lives as the result of oral diseases and disorders.²⁰ The possible mechanism by which emotional and social well-being is affected in adolescents likely concerns the esthetic effect of the enamel fracture. Adolescents are particularly affected even by small esthetic alterations, as have been demonstrated with regard to malocclusion.^{14,21,22} Although the negative impact of enamel fractures on the functional limitation domain is more difficult to explain, it is possible that the

TABLE 3 Differences in means between clinical conditions and both overall CPQ₁₁₋₁₄ and domain scores

Clinical condition	Oral symptoms	Functional limitation	Emotional well-being	Social well-being
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Overall	3.84 (2.68)	2.41 (2.60)	2.81 (3.41)	1.71 (2.43)
Exposure: All TDI				
No	3.81 (2.65)	2.34 (2.61)	2.67 (3.32)	1.63 (2.34)
Yes	4.03 (2.90)	2.91 (2.46)	3.85 (3.88)	2.37 (2.90)
	<i>P</i> = .645	<i>P</i> = .006	<i>P</i> = .003	<i>P</i> = .014
Exposures: Enamel fracture and Other TDI				
Without TDI	3.81 (2.65)	2.34 (2.61)	2.67 (3.32)	1.63 (2.34)
Enamel fracture	4.03 (2.94)	2.85 (2.34)	3.92 (3.84)	2.41 (2.72)
Other TDI	4.05 (2.84)	3.16 (2.93)	3.58 (4.13)	2.21 (3.57)
	<i>P</i> = .897*	<i>P</i> = .022*	<i>P</i> = .011*	<i>P</i> = .039*
	<i>P</i> = .698**	<i>P</i> = .014**	<i>P</i> = .004**	<i>P</i> = .012**

*Comparison between the three categories.

**Comparison between enamel fracture and “without TDI.”

perception of the missing portion of the tooth makes adolescents with such injuries report, at least unconsciously, greater difficulty with biting or chewing harder foods.

Traumatic dental injuries are the fifth most prevalent disease/injury in the world²³, and enamel fracture is the most frequent among all dental injuries.⁶⁻⁹ However, enamel fracture is the least severe form of TDI.¹¹ When not associated with luxation, the prognosis of these injuries in the long-term is favorable, as the risk of pulp necrosis and infection of the root canal system, pulp canal obliteration and root resorption is 1.7%, 0.5%, and 0.2%, respectively.¹² The favorable prognosis and the fact that enamel fractures are common findings in the dental office mean that these injuries are often overlooked during the diagnosis and planning of treatment. However, OHRQoL is one of the most important outcomes to consider regarding diagnosis and treatment in dental traumatology.¹ A recent longitudinal study demonstrated that the restorative treatment of crown fractures involving enamel and dentin improves the OHRQoL of children and adolescents.⁵ However, the impact of treatment for enamel fractures only on the satisfaction or OHRQoL of adolescents is not yet known.

The most important clinical implication of the present study is that dentists should pay particular attention to the diagnosis of enamel fractures of permanent teeth and evaluate each case with regard to the impact on the emotional and social well-being of adolescent patients. Not considering the negative perception of the adolescent toward this type of TDI could lead to the maintenance of the negative impact on OHRQoL in cases for which the dentist decides not to restore the tooth. Likewise, unnecessary expenditure, time consumption and the onset of an unnecessary restoration cycle can occur when a dentist decides to restore a tooth with an enamel fracture for which the adolescent patient reports no impact.

As expected, the impact on OHRQoL was greater among girls than boys, which is in agreement with data described in previous

studies.^{14,24} Gender differences may be explained by greater dissatisfaction with one's self-image and the potential impact that dentofacial esthetics exert on interpersonal relationships among girls. Women are more sensitive and exhibit greater concern with the perception of their appearance and oral health than men.^{25,26}

The findings of the present study support the hypothesis that lower mother's schooling is associated with worse OHRQoL in adolescents, which has been reported in a previous study.²⁷ The possible mechanism for this finding is related to children from mothers with a lower education being more likely to be exposed to risk factors and diseases.^{28,29} Consequently, these children have worse quality of life scores. Moreover, as parents bear the responsibility for taking their children to a dental office for care, mothers with a lower level of schooling may underestimate the need to seek early dental care, which can exert a negative impact on the oral health of their children.³⁰

Some comments on the methods employed in the present study are relevant. The cross-sectional design is a limitation as it does not allow drawing of conclusions regarding cause-and-effect relations. The external validity of the sample analyzed is supported by information from local authorities, indicating that most adolescents in the target age range in the city of Santo Ângelo are enrolled in public schools, which ensured a representative sample of the population. The use of a validated instrument to assess the outcome, the adequate statistical power and the acceptable level of intra-examiner agreement enhanced the internal validity of the study. The multivariate analysis allowed the estimation of more accurate effect measures, thereby reducing the possibility of an association found due to confounding variables or at random. The findings can be generalized to populations with similar cultural and demographic characteristics to those who live in southern Brazil.

In conclusion, the findings demonstrate that enamel fracture exerts a negative impact on the OHRQoL of adolescents, especially affecting emotional and social well-being. These findings

underscore the need for the incorporation of subjective measures, which may influence health outcomes and contribute to a better quality of life.

CONFLICT OF INTEREST

The authors confirm that they have no conflict of interest.

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