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The relationship between tooth wear in the primary and permanent dentitions

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Objective: To evaluate the relationship between tooth wear in primary and permanent dentition in 7 to 10-year-old school children, in 2007. ***Methods:*** An epidemiological cross-sectional survey was conducted by trained, calibrated examiners, using the dental wear index (DWI). The cluster sample consisted of 764 children (382 boys, 382 girls) attending 4 public schools selected in different regions of the city. The DWI was proposed to evaluate primary and permanent teeth, coded as letters and numbers, respectively. Data were collected via clinical examinations performed outdoors under natural light, following the WHO recommendations and using a dental mirror and probe. Proportions and confidence intervals were used to describe the prevalence of dental wear. The Mann-Whitney and the Odds Ratio (OR) tests were used to compare the tooth wear prevalence between primary and permanent teeth according to surface ($p<0.05$). ***Results:*** The 7 to 10-year-old school children presented 16% tooth wear. The tooth wear was mostly seen on the occlusal/incisal surfaces (47%), involving enamel or enamel-dentine. Tooth wear in primary teeth was found in canines and molars (93%) and in permanent teeth in molars (34%). There was significant difference between primary and permanent teeth ($p<0.001$) and dental wear in primary teeth was greater in boys than in girls ($p=0.02$) but not in permanent teeth. ***Conclusion:*** The results suggest that 7 to 10-year-old children with tooth wear in primary teeth had more chances of developing tooth wear in permanent dentition. However, the findings of this study are not conclusive as the associations described are not causal.

Key words: *tooth wear, erosion, abrasion, attrition, children, oral health*

Introduction

Tooth wear is the loss of mineralized tooth substance from the tooth surface as a result of physical and/or chemical attack (Lee and Eakle, 1984). The mechanisms likely to be associated with the development of lesions (erosion, abrasion, attrition and tooth flexure) are not distinct and separate but may operate together simultaneously to initiate and develop lesions (Eccles, 1982). Tooth attrition is the physiological condition (Eccles, 1982) represented by a regular, slow, progressive loss of dental tissues as a consequence of tooth to tooth contact, as in mastication (Bartlett and Shah, 2006). However, if tooth attrition occurs due to bruxism, it will be considered pathological attrition. Tooth abrasion is a pathological loss of hard tooth substance because of friction with a foreign body, abnormal processes, habits, or abrasive substances (Bergstron and Eliasson, 1988). Tooth wear and abrasion must be distinguished from erosion, which is a loss of dental hard tissues caused by chemical agents, without the intervention of bacteria (Lussi *et al.*, 1991).

Wear is often the result of a complex combination of causes and has been widely reviewed in the dental literature (Bartlett *et al.*, 1998; Sales-Peres *et al.*, 2008). Since there is increasing prevalence of tooth wear, identification of risk factors is very important for diagnosis, prevention and treatment though there are fewer epidemiological studies of tooth wear than might be expected considering the high prevalence of these lesions (Bartlett *et al.*, 1998; Sales-Peres *et al.*, 2008).

Abnormal tooth wear is difficult to distinguish from normal wear and no single index has been universally accepted (Sales-Peres *et al.*, 2008; Smith and Knight, 1984). Studies with the aim of analyzing tooth wear initially focused on clinical evaluation of the lesions, by estimating their severity and later also reported the distribution of lesions (Eccles, 1982; Sales-Peres *et al.*, 2008; Smith and Knight, 1984).

Sales-Peres *et al.* (2008) proposed a modification of the TWI (Tooth Wear Index) to fit in with the WHO (1997) standards and allowing the index to be applied in broad epidemiological surveys. This modification included a code for teeth restored due to wear and another for teeth which could not be assessed. Moreover, the modified index does not differentiate the depth of dentine involvement (Table 1).

Data with regard to the prevalence of dental erosion in Brazil is scarce. Peres *et al.* (2005), found a prevalence of 12% among 12-year-old schoolchildren, but only the four maxillary incisors were evaluated. Sales-Peres *et al.* (2008) found the prevalence of dental wear was 26.9% for same age, however they investigated all teeth as well as buccal, occlusal/incisal and lingual/palatal surfaces. Considering the different teeth, there was wear in 53.2% of incisors, 50.5% of canines, 10.2% of pre-molars and 10.9% of molars. The wear lesions on tooth surfaces were most prevalent on the occlusal or incisal surfaces (79.7%).

Risk predictor was re-named risk marker by Beck (1998), and it is defined as a characteristic associated with a high risk for the disease. The risk predictor predicts

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well but it is not thought to be part of the causal chain. Moreover, according to Beck (1998), a prediction model allows increased sensitivity and specificity (the proportions of individuals correctly classified with or without the disease) of the prediction.

Between the ages 7-10 years, both types of dentition coexist, sharing exposure to agents of dental wear. The impact of these wear-promoting conditions has not been described in the literature. The aim of this study was therefore to measure the prevalence and severity of dental wear and evaluate the relationship between tooth wear in primary and permanent dentition in a stratified sample of 7-10-year-old children, using a modification of the TWI. This modification was proposed to broaden epidemiological surveys, to assess whether tooth wear in primary teeth was a prediction of its occurrence in permanent dentition.

Methods

All school children (n=1,400) of both genders attending the 4 public schools were invited to participate. Informed consent forms were returned by the parents of 845, in conformity with the Helsinki declaration. Some 764 7-10 year olds (382 girls, 382 boys) presented for examination and participated in this cross-sectional study conducted in a middle-sized city (40,270 inhabitants) in the state of São Paulo, Brazil.

All volunteers received a toothbrush, toothpaste and dental floss, and participated in oral health education activities. Those who presented treatment needs were referred to dental care offices.

The epidemiological surveys were conducted under natural light in an outdoor setting, using a mirror and dental CPI probe (WHO, 1997). The schoolchildren sat down on school chairs, the examiners stood in front of them, and used the modified TWI index for tooth wear examination, according Sales-Peres *et al.* (2008). The modifications were made to allow the index to be applied to broad epidemiological surveys, in both primary and permanent dentition, so that it could fit in with the WHO (1997) standard. The surfaces were scored as "A" or "0" (normal), "B" or "1" (enamel involvement), "C" or "2" (exposed dentine), "B" or "3" (secondary dentine or pulp exposure), "E" or "4" (restored due tooth wear) and "-" or "9" (could not be assessed) for primary and permanent teeth, respectively. Buccal/facial, incisal/occusal, and lingual/palatal surfaces were examined and recorded on a specific form.

Four examiners performed the clinical examinations outdoors having been trained during calibration sessions before starting the fieldwork. Theoretical discussions were held, and practical activities performed as regards the diagnostic criteria of dental wear. The general agreement percentage and Kappa values were measured for intra-examiner (0.91 and 0.88) and inter-examiner (0.88 and 0.82), respectively. Before examination each volunteer brushed their teeth supervised by a dental hygienist.

The data analysis consisted of descriptive statistics such as mean, standard deviations and relative frequencies. Tooth surfaces coded -/9 were excluded from the statistical analysis as they were missing, had extensive caries, large restorations, fractures, or had orthodontic brackets cemented to them. The Mann-Whitney test was used to detect differences between groups. Differences in prevalence were compared by the Odds ratio (OR) test. Tests were performed using Epi-Info 6.01 software at 5% level of significance.

Results

The 7-10-year-old school children presented 16.4% tooth wear. A total of 52,451 dental surfaces were evaluated. Among these surfaces, 83.6% presented no dental wear, 24.5% and 5.2% had incipient lesions, 7.1% and 0.08% had moderate lesions, 0.07% and 0.01% had severe lesions and 0.04% and 0.06% had been restored in primary and permanent teeth, respectively. Tooth wear was mainly seen on the occlusal/incisal surfaces (47.3%), involving enamel or enamel-dentine (Table 1).

The prevalence of tooth wear in primary teeth was 73.8% in incisors, 93.0% in canines and 92.8% in molars (Table 2). The prevalence of lesions in the permanent dentition were 7.1% in incisors, 6.0% in canines, 7.2% in premolars and 33.8% in molars.

Tooth wear was shown in more primary than permanent teeth, 99.4% cf 57.1% ($p<0.001$); the degrees of wear were 58.6% and 38.6% in primary enamel and enamel+dentine, and 53.9% and 2.0% in permanent teeth, respectively (Table 3). There was greater dental wear among boys than girls for primary teeth ($p=0.02$) but not for permanent teeth (Table 4).

Table 5 shows that primary teeth were more likely to have tooth wear on the buccal (OR=9.00; $p<0.001$) and lingual surfaces (OR=7.18; $p<0.01$) when compared with permanent teeth. Because the majority of the incisal/occlusal surfaces showed some degree of tooth wear, it was impracticable to perform the breakdown analysis of these surfaces.

Discussion

For successful management of tooth wear, it is essential to identify the etiological factors. In many cases, the diagnosis may be complicated because multiple etiologic factors may confound the clinical appearance of tooth wear (Raigrodski and Dogan, 2008). Predicting future tooth wear is important for monitoring individuals at risk of developing wear.

The prevalence of tooth wear has been reported in several studies that have used many indexes for analysis (Eccles, 1982; Sales-Peres *et al.*, 2008; Smith and Knight, 1984). Not only have different indices been used, but different teeth and surfaces have been examined and results presented in various ways, which has made it difficult to make comparisons between studies. In this study the DWI for epidemiological surveys was used, which showed fair to good accuracy and validity. Other working groups will have to conduct studies to validate the diagnostic criteria and grading.

The differences in the prevalence data among many studies (Smith and Knight, 1984; Sales-Peres *et al.*, 2008; Wiegand *et al.*, 2006) may be partly explained by the differences in diagnostic criteria and indexes used, as well as varying socioeconomic, cultural and geographical factors which could influence the outcome of prevalence data.

In the present study the mean DWI across all partici-

Table 1. Distribution of the severity and prevalence of the lesions according to the surfaces examined.

Primary Dentition		*Buccal*	*Occlusal/ Incisal*	*Lingual/ Palatal*
Severity	*Degree*	*% (n=7322)*	*% (n=7293)*	*% (n=7300)*
	A	98.4	7.6	98.7
	B	1.4	71.3	1.0
	C	0.2	20.9	0.3
	D	0	0.2	0.1
	E	0	0.1	0.0
Prevalence		1.6	92.4	1.3
Permanent Dentition		*Buccal*	*Occlusal/ Incisal*	*Lingual/ Palatal*
Severity	*Degree*	*% (n=10188)*	*% (n=10173)*	*% (n=10175)*
	0	99.2	85.1	99.7
	1	0.7	14.7	0.3
	2	0.2	0.2	0.0
	3	0.0	0.0	0.0
	4	0.0	0.1	0.1
Prevalence		0.8	14.9	0.4

Table 2. Distribution of the severity or prevalence of the lesions according to the different types of teeth in primary and permanent dentition

Primary Dentition		*Incisors*	*Canines*		*Molars*
Severity	*Degree*	*% n=439*	*% n=2262*		*% n=4633*
	A	26.2	7.0		7.2
	B	56.0	55.8		79.6
	C	17.3	37.0		12.9
	D	0.5	0.1		0.2
	E	0.0	0.0		0.2
Prevalence		73.8	93.0		92.8
Permanent Dentition		*Incisors*	*Canines*	*Premolars*	*Molars*
Severity	*Degree*	*% n=5399*	*% n=569*	*% n=1139*	*% n=3122*
	0	92.9	94.0	92.8	66.2
	1	6.9	5.8	6.5	33.3
	2	0.2	0.2	0.1	0.4
	3	0.0	0.0	0.1	0.0
	4	0.0	0.0	0.5	0.2
Prevalence		7.1	6.0	7.2	33.8

Table 3. Distribution of the severity of the lesions according to the type of dentition.

	Degree of severity of lesions % of surfaces (95% confidence interval)				
*Dentition**	*A or 0*	*B or 1*	*C or 2*	*D or 3*	*E or 4*
Primary Dentition n=710	0. 6% (0.2-1.4%)	38.6% (35.0-42.3%)	58.6% (54.9-62.2%)	1.6% (0.8-2.8%)	0.7% (0.2-1.6%)
Permanent Dentition n=764	42.9% (39.4-46.5%)	53.9% (50.3-57.5%)	1.96% (1.10-3.22%)	0.3% (0.0-0.9%)	0.9% (0.4-1.9%)
Total n=1474	22.5% (20.4-24.7%)	46.6% (44.0-49.1%)	29.3% 26.9-31.6%)	0.9% (0.5-1.5%)	0.8% (0.4-1.4%)

* Significant difference between the primary and permanent teeth ($p<0.001$)

Table 4. Distribution of the severity of the tooth wear by gender for primary and permanent teeth

	Degree of wear in Primary Teeth % within gender*					
Genders	*A*	*B*	*C*	*D*	*E*	*n*
Male	0.8%	34.5%	61.6%	2.5%	0.6%	362
Female	0.3%	42.8%	55.5%	0.6%	0.9%	348
n	4	274	416	11	5	710
	Degree of wear in Permanent Teeth % within gender*					
Genders	*0*	*1*	*2*	*3*	*4*	*n*
Male	42.4%	53.1%	2.9%	0.5%	1.8%	382
Female	43.5%	54.7%	1.1%	0.0%	0.8%	382
n	328	412	15	2	7	764

* Significant difference was detected between the genders for the different degrees in primary dentition (p=0.02).

** No significant difference was detected between the genders for the different degrees in permanent dentition (p>0.05).

Table 5. The association of wear on buccal and lingual surfaces in primary and permanent dentitions

Buccal Surfaces	*Permanent Dentition*				
Primary Dentition	*with wear*	*without wear*	*OR*	*CI 95%*	*p*
with wear	20	37	9.0	4.8-17.0	<0.001
without wear	37	616			
Lingual Surfaces	*Permanent Dentition*				
Primary Dentition	*with wear*	*without wear*	*OR*	*IC 95%*	*p*
with wear	9	47	7.2	3.0-17.0	<0.001
without wear	17	637			

pants was 16.4%, with the incisal/occlusal surfaces most frequently affected by tooth wear in primary and permanent dentition (92.4% and 15.0%, respectively, see Table 2).

The etiopathology of noncarious lesions is multifactorial and still not fully understood. Tooth wear is defined as loss of dental hard tissue by a chemical or mechanical process that does not involve bacteria (Tomasik, 2006). The enamel and dentine structures of primary teeth differ from those of permanent teeth, having thinner enamel and dentine layers and less mineralization (Wilson and Beynon, 1989). The present study confirmed that the primary canines were most affected as noted elsewhere (Harding *et al.*, 2003; Wiegand *et al.,* 2006). However, the molars showed similar tooth wear to canines, 92.8% and 93.0%, respectively, possibly because of the time of exposure to tooth wear in the mouth.

In a recent study (El Aidi *et al.*, 2008), the prevalence of tooth wear was found predominantly on the incisors and on the molars in permanent dentition. In the present study, the most affected teeth were the molars (33.8%) (Table 2). The evidences supported the fact that these teeth were the most affected by all non-carious lesions, such as attrition and erosion for a longer period of time.

Non-carious-lesions have been investigated: most commonly dental erosion. In primary dentition, erosive tooth wear was identified in dentine (Walker *et al*, 2000; Wiegand *et al.*, 2006) and the most affected teeth were the molars (El Aidi *et al.*, 2008; Walker *et al*., 2000), incisors (Wiegand *et al*, 2006) or canines (Harding *et al.*, 2003). In permanent dentition, tooth erosion was more frequently found in enamel (Bartlett *et al.*, 1998; Deery *et al.*, 2000; Dugmore and Rock, 2004; Ganns *et al.*, 2001; Walker *et al.*, 2000) and the teeth most affected by wear were the molars (El Aidi *et al.*, 2008) and canines (Bartlett *et al.*, 1998). The present study analyzed non-specific tooth wear that included any type of wear. The results suggested that canines and molars presented higher tooth wear indexes than the other groups of teeth.

The occurrence of tooth wear in canines and molars might be correlated with the keys to occlusion, however, additional research is necessary to support the correlation between malocclusion and tooth wear described in the scientific literature.

The most frequently found type of severity involved only enamel as has been found in most other studies for a similar age-bracket (Bartlett *et al.*, 1998; Ganss *et al.*, 2001).

It was found that the greatest degree of tooth wear occurred in enamel on the buccal, occlusal/incisal, lingual/palatal surfaces of both primary and permanent teeth (Table 3) confirming the important role of different dental surfaces with regard to accelerated tooth wear.

Many etiological factors seem to influence tooth wear, and it was verified that there was an association between the different lesions evaluated and gender. This study found no significant differences between boys and girls, in the prevalence and severity of dental wear in permanent teeth, which has also been reported by Peres *et al.* (2005) in the Brazil and by Deery *et al.* (2000) in the UK and USA. On the other hand, a significantly higher prevalence of exposed dentine was found in UK boys than in girls and more boys had buccal/labial and lingual/palatal tooth surface erosion than girls (Al Dlaigan *et al.,* 2001; Dugmore and Rock, 2004). In the present study, boys had a significantly higher prevalence and severity of tooth wear than girls in primary dentition, which confirms the findings of several authors (Al-Dlaigan *et al.*, 2001; Peres *et al.*, 2005) although others found no gender difference (Bartlett *et al.*, 1998; Walker *et al.*, 2000).

Van Rijkom *et al* (2002) suggested that the bite force could explain the difference in prevalence of erosive tooth wear between boys and girls. El Aidi *et al.* (2009) reported that tooth erosion progressed faster in boys than in girls. One could imagine that a person would be exposed the same risk of tooth wear occurring in primary and permanent dentition. However, there was no gender difference found in their permanent dentition. The difference in enamel formation between primary and permanent teeth combined with other variables such as bite force could explain the anomaly. These suggestions need further investigation.

Dental erosion in primary dentition is regarded a predictor of increased risk of erosion and general tooth wear in permanent dentition. So precise preventive and therapeutic measures are necessary to avoid increasing clinical problems (Ganss *et al.*, 2001). This study showed that tooth wear in primary teeth was related to disease in permanent teeth with a strong correlation between wear on the vestibular and lingual faces of primary teeth and on permanent teeth. However, the findings of this study are not conclusive as the associations described are not causal.

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