Interproximal Contact Points and Proximal Caries in Posterior Primary Teeth

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Abstract

Purpose: The purpose of this study was to investigate the hypothesis that the risk of proximal caries in posterior primary teeth is higher when interproximal contact points are closed than when they are open.

Methods: A cross-sectional study design was used with a sample of 286 children aged 24 to 72 months (mean age 54 months±16 months). Children with any permanent dentition were excluded. Caries (defined as a lesion halfway through enamel or further) was assessed radiographically by a single dentist. The open/closed nature of contact points was assessed by a different dentist through resistance to dental floss. Data concerning known risk factors and indicators for caries were also collected. Analyses were performed at the level of the contact point, comparing the same contact points in different children. Multiple logistic regression was used to asses the relationship between open/closed status and caries status for each posterior contact point.

Results: In 7 of the 8 contact points examined, the odds for caries were significantly increased when contact points were closed.

Conclusions: This research suggests that the risk for proximal caries in the posterior primary dentition is raised if contact points are closed compared to those that are open. (*Pediatr Dent*. 2003;25:334-340)

KEYWORDS: DENTAL CARIES, PROXIMAL CARIES, PRIMARY DENTITION, CONTACT POINTS

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The etiology of caries in the primary dentition has seen relatively little research when compared to that of the permanent dentition. Although many risk factors for caries in permanent teeth are the same as those for primary teeth, there are some potential and real differences. The recognition of the relatively poor understanding of caries in the primary dentition was one of the driving forces for a recent conference on early childhood caries (ECC) in Bethesda.[1] As part of that conference, a comprehensive review of the biological mechanism of ECC was performed, discussing, among other issues, the role of plaque and its host.[2] Nevertheless, the roles of tooth type, site, and position/spacing were not discussed, presumably reflecting the lack of research in this field. In the permanent dentition, it has been shown that caries patterns at the 3 principal sites (pit and fissure, proximal, and smooth surfaces) differ with varying levels of disease in the population.[3] This suggests that the role of the different tooth sites in the natural history of caries is important to understand.

The relative incidence of caries at occlusal, proximal, and smooth surface sites in the primary dentition is equivocal with different studies reporting varying findings.[4] However, the most recent studies of the primary dentition in North American populations suggest that more carious lesions arise in molars than in anterior teeth.[4,5] While patterns of caries in different tooth types and sites in the primary dentition has seen some research, the role of tooth position/spacing has seen very little research. The findings of a longitudinal study of proximal caries in the United Kingdom suggested that initiation of such lesions is related to the presence of a proximating tooth.[6]

Another more recent study has reported that, in 69% of posterior primary teeth with proximal caries, the disease subsequently developed in the adjacent proximal site.[7] This could be a reflection of the risk of the whole mouth for

Table 1. Descriptive Data for the Sample

Variable	n (%)
Gender	
Female	119 (42%)
Male	167 (58%)
Age	
24-36 mo	25 (9%)
37-48 mo	56 (20%)
49-60 mo	83 (29%)
61-72 mo	122 (43%)
Age of eruption of first tooth	
≤5 mo	44 (15%)
6-8 mo	189 (66%)
9-11 mo	30 (11%)
≥12 mo	23 (8%)
Tooth-brushing frequency	
<1/d	24 (8%)
1/d	93 (33%)
>1/d	169 (59%)
Person cleaning teeth	
Child alone	42 (15%)
Child with supervision	73 (26%)
Parent/combination	171 (60%)
Flossing frequency	
Daily	48 (17%)
Weekly	33 (12%)
Never	205 (72%)
Ever used fluoride supplementation	
Yes	104 (36%)
No	182 (64%)
Breast-fed baby	
Yes	175 (61%)
No	111 (39%)
Present use of nighttime bottle	
Yes	37 (13%)
No	249 (86%)
Country of birth of primary caregiver	
Canada	162 (57%)
Other	124 (43%)
Marital status of primary caregiver	
Married/living with partner	221 (72%)
Single/separated/divorced/widowed	65 (23%)
Years of formal education of primary caregiver	
≤5 y	107 (37%)
6-9 y	97 (34%)
≥10 y	82 (29%)
Family revenue	
<$10,000	31 (11%)
$10,000-$29,000	75 (26%)
$30,000-$49,000	38 (13%)
≥$50,000	19 (7%)
Not revealed	121 (43%)
Fluoridated water supply	
Yes	13 (5%)
No	273 (96%)

caries, as indicated by the well-recognized observation that a history of caries is a good predictor of future lesions,[8] and/or it could be a reflection of the local environment. The local environment could mediate caries through one site, infecting a second site or the whole interproximal area if it is a site more prone to caries, due to, for instance, plaque accumulation. In this sense, it is interesting to note that the study of Dean et al reported that of the sites where adjacent caries lesions developed, 61% of lesions were diagnosed simultaneously while the remaining 39% were diagnosed up to 5 years later.[7] One possible explanation of this observation is that interproximal contact points are difficult to clean and, as such, accumulate plaque, resulting in an increased risk for caries. If this is the case, one could hypothesize that open contact points would be less prone to caries than closed contact points because they are less likely to accumulate plaque. This hypothesis is eminently testable in the primary dentition where gaps between teeth are very common and even normal.[9] The aim of this study was, therefore, to address the hypothesis that, in the posterior sextants of the primary dentition, the risk of proximal caries when interproximal contact points are closed is greater than the risk of such caries in sites with open interproximal contact points.

Methods

Study design and subjects

A cross-sectional study design was used with subjects being recruited as a convenience sample of children attending the Dental Department of the Montreal Children's Hospital. The research was granted approval by the appropriate Hospital Institutional Review Board, and all subjects had a consent form signed for them by an accompanying guardian. Subjects were approached on the basis of age (24-72 months), but were excluded if they either had none of the contact points of interest (a potential contact point was deemed to be present as soon as a cusp of the second tooth of the contact point was visibly erupting) or had 1 or more erupting or erupted permanent teeth. The contact points of interest were the 2 most posterior ones in each quadrant (ie, between the second and first molars and between the first molar and canine in each quadrant). Children were also excluded if they had taken medications for more than

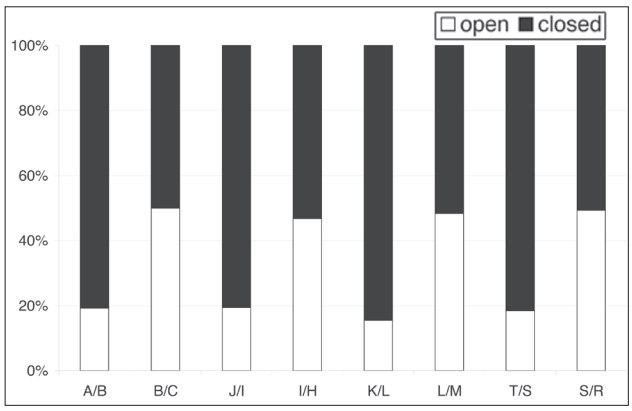

Figure 1. Proportion of interproximal spaces with open and closed contact points.

4 weeks in the previous year and if they were currently under treatment for any health problem other than dental caries (including oral, such as cleft palate, and general health problems, such as asthma).

Variables

The dependent variable in this study (interproximal caries status) was evaluated through bitewing radiographs by a dentist blind to the study hypothesis and the clinical evaluation of the open/closed nature of the contact points. Caries was defined as any lesion halfway through the enamel or further. This dentist evaluated each of the 16 interproximal sites as healthy, carious, or restored. No evaluation of the reliability of the caries evaluation was performed.

The key independent variable (open/closed nature of the contact points) was assessed by a dentist (different than the one making the caries evaluation) as resistant or not resistant to dental floss when the latter was passed through the interproximal contact point. If the dentist felt resistance, the contact point was scored as closed, and if there was no resistance, it was scored as open. This evaluation was made in all cases by the same dentist who was again blind to the study hypothesis and different to the dentist evaluating caries. No evaluation of the reliability of the contact status evaluation was performed.

Other data concerning known risk factors and indicators for dental caries (age and gender of child, age at eruption of first tooth, country of birth and education of primary caregiver, family revenue, tooth-brushing frequency, use of dental floss, fluoride supplement use and consumption of fluoridated water, use of nighttime bottle, and contents of bottle) were collected by questionnaire. To control for the length of time the relevant teeth and contact points had been in the mouth, the authors collected data on the child's age at eruption of the first tooth. This was based upon the parental report of that age. The authors then generated an indicator of time since eruption of the first tooth by subtracting age at eruption of first tooth from age at time of inclusion in study (all data measured in months). This variable was not the actual time the relevant teeth and contact points had been present, but it was assumed that there is a fairly linear relationship between time of eruption of the first tooth and all remaining teeth such that if the first one is late by 2 months, all other teeth will be late by the same margin.

Statistical analyses

The sample size calculations were based upon the assumption that 50% of children would have closed contact points and 70% would have caries in the posterior sextants of their mouth. To have 90% power to detect an odds ratio (OR) of 2 for interproximal caries with closed vs open contact points (if that difference exists), a sample size of 286 subjects was required. Once data were collected and following descriptive statistics, bivariate analyses of any association between interproximal caries status and any independent factors were performed through the generation of odds ratios. An OR is a comparison of the chances of an event happening between 2 or more groups. For example, in Table 3 the odds for caries being present among males was 36/106=0.34, while the odds for caries in females was 26/73=0.36, and the OR using males as the reference group was 0.36/0.34=1.1. The 95% confidence interval (CI) is a recognition that the OR quoted is an estimate of the true

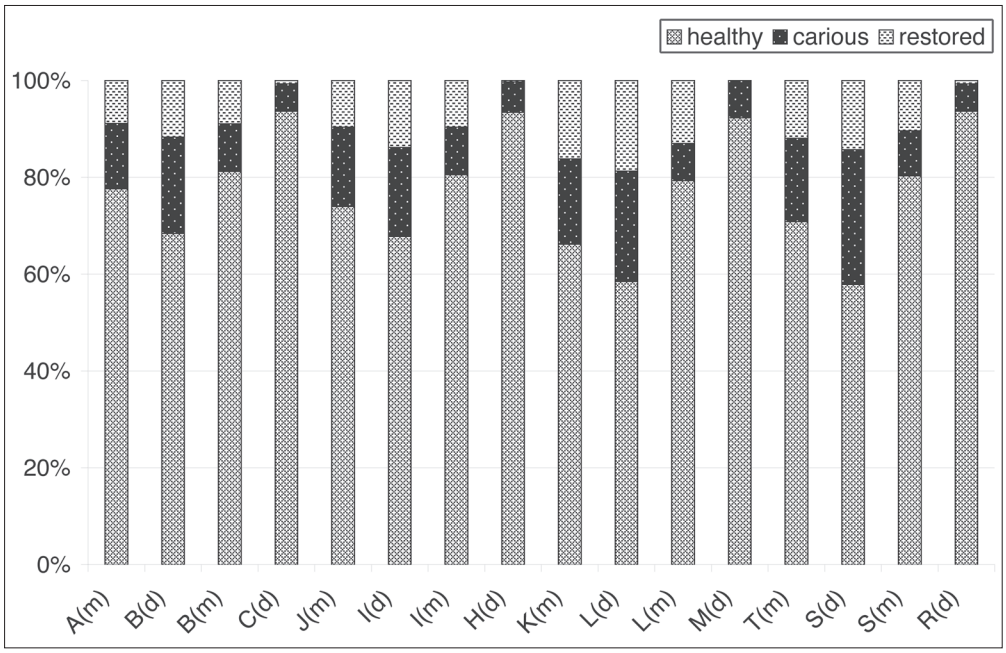

Figure 2. Caries status at each interproximal site.

Table 2. Odds Ratios for Untreated Caries With Selected Independent Variables Using Interproximal Site A/B as an Example

Variable	Caries status (healthy/carious)	Odds for caries	OR	95%CI
Gender				
Male	106/36	0.34	Ref	
Female	73/26	0.36	1.1	0.6-2.0
Time since eruption of first tooth				
≤36 mo	55/12	0.22	Ref	
37-48 mo	37/12	0.32	1.5	0.6-3.7
49-60 mo	49/22	0.45	2.0	0.9-4.5
m≥61 mo	38/16	0.42	1.9	0.8-4.5
Brushing frequency				
>1/d	112/30	0.27	Ref	
Once daily	55/22	0.4	1.5	0.7-3.4
<1/d	12/10	0.83	3.1	1.2-7.9
Flossing frequency				
Daily	30/12	0.4	Ref	
Weekly	23/4	0.17	0.4	0.1-1.6
Never	126/44	0.35	0.9	0.4-1.9
Ever used fluoride supplementation				
Yes	78/18	0.23	Ref	
No	101/44	0.44	1.9	1.0-3.5
Child was breast-fed				
Yes	107/42	0.39	Ref	
No	72/20	0.28	0.72	0.4-1.3
Current use of nighttime bottle				
Yes	19/12	0.63	Ref	
No	160/50	0.31	0.5	0.2-1.1
Country of birth of primary caregiver				
Canada	103/28	0.27	Ref	
Elsewhere	76/34	0.45	1.7	0.9-3.0
Marital status of primary caregiver				
With partner	138/52	0.38	Ref	
Single	41/10	0.24	0.6	0.3-1.4
Years of formal education of primary caregiver				
≤5 y	63/12	0.19	Ref	
6-9 y	47/14	0.3	1.6	0.7-3.7
≥10 y	42/12	0.29	1.5	0.6-3.7
Family revenue				
<$10,000	13/8	0.62	Ref	
$10,000-$29,000	53/14	0.26	0.4	0.1-1.2
≥$30,000	39/14	0.36	0.6	0.2-1.7
Not revealed	74/26	0.35	0.6	0.2-1.5

difference in odds for caries between the groups based on the data from the study sample. Again, with the authors' gender example, based upon data from their study, the authors can be 95% sure that the real OR for caries among females compared to males lies between 0.6 and 2.0. In the case of OR, when the 95% CI crosses 1, then it is presumed that there are not significantly different odds for the event happening between the 2 groups concerned. In the authors' example, between males and females there is no difference in odds to have caries. Where there are more than 2 categories (eg, brushing frequency), the reference group remains the same for the generation of each OR. For example, with brushing frequency, the OR cited relate to a comparison of odds to have caries in the group brushing once daily vs those brushing more than once daily (OR=1.5) and a comparison of odds to have caries in the group brushing less than once daily vs those brushing more than once daily (OR=3.1).

The level of analysis was the interproximal contact point, of which there were 8. Each interproximal contact point was categorized as healthy if both relevant interproximal sites were healthy. They were categorized as carious if one or both sites had untreated lesions, and restored sites were excluded as it was not possible to say whether the contact point had been open or closed prior to the restoration. Finally, the association between interproximal caries and contact point status was analyzed while controlling for other independent and confounding factors using multiple logistic regression analysis. Those variables included in the multivariate model were considered on the basis of their having a nonassociation with caries probability of $P<.1$ at the bivariate level of analysis.

Results

Descriptive statistics for the sample are shown in Table 1. The sample consisted of 286 children with a small majority of males and an age distribution skewed towards the older end of the range of 24 to 72 months (mean age=54 months±16 months). The majority of children had their teeth cleaned more than once a day, and this was done in the majority by a combination of child and parent. A small proportion of respondents claimed to use floss daily or weekly, and approximately one third claimed it had ever received fluoride supplementation, although very few were living in areas with fluoridated water supplies. A large proportion of the sample were relatively recent immigrants as indicated by the proportion of primary caregivers having been born outside Canada. Figures 1 and 2 respectively demonstrate the open/closed status of the interproximal contact points and the caries status of each of the 16 interproximal tooth sites. Both figures show very symmetrical patterns. With respect to the open/closed status of the contact points, all 4 of the more posterior contact points were closed 80% to 84% of the time, while all 4 of the more anterior contact points were closed 50% to 53% of the time. Similarly, with respect to the caries status, the distal aspect of the first molar in each quadrant consistently demonstrated the highest

level of caries experience, while the canine in each quadrant had the least caries experience. An additional observation is that the mandibular teeth, especially the sites around the more posterior of the 2 contact points, had a greater caries experience than the maxillary teeth.

Table 2 demonstrates the association between potential independent predictors of caries and the dependent variable (interproximal caries status), taking the site between the upper right first and second molars as an example. As stated in the methods section, the interproximal contact point was categorized as healthy if both sites were healthy and carious if one or both sites had active disease. Contact points with 1 or more restorations were excluded. Table 2 shows that increased brushing frequency and use of fluoride supplementation were significantly associated with decreased odds for caries, while increased time in mouth (of the teeth), current use of a nighttime bottle, and a primary caregiver country of birth other than Canada all showed strong tendencies for increased odds for caries. Finally, Table 3 demonstrates the relationship between the open/closed nature of the contact points and their caries status, controlling for brushing frequency, fluoride supplementation, time in mouth, current nighttime bottle use, and country of birth of the primary caregiver through multiple logistic regression analysis. Once again, any contact points with a restoration present were excluded from these analyses. With the exception of the interproximal site between the lower left canine and first molar, all sites showed a significantly increased OR for caries vs a healthy tooth if the contact point was closed.

Table 3. Odds Ratios for Untreated Caries With Open and Closed Interproximal Sites

Interproximal site	Open/closed status	Caries status	N	Odds for caries	OR*	95%CI
A/B (37 restored sites excluded)	Open	Healthy Carious	43 4	0.09	Ref	
	Closed	Healthy Carious	136 58	0.43	4.8	1.6-14.0
B/C (25 restored sites excluded)	Open	Healthy Carious	130 4	0.03	Ref	
	Closed	Healthy Carious	97 26	0.27	9.0	3.0-26.6
J/I (37 restored sites excluded)	Open	Healthy Carious	41 6	0.15	Ref	
	Closed	Healthy Carious	136 56	0.41	2.7	1.1-6.7
I/H (27 restored sites excluded)	Open	Healthy Carious	116 8	0.07	Ref	
	Closed	Healthy Carious	105 26	0.25	3.6	1.6-8.3
K/L (53 restored sites excluded)	Open	Healthy Carious	34 1	0.03	Ref	
	Closed	Healthy Carious	122 67	0.55	18.3	2.4-136.7
L/M (37 restored sites excluded)	Open	Healthy Carious	109 10	0.09	Ref	
	Closed	Healthy Carious	110 18	0.16	1.8	0.8-4.1
T/S (38 restored sites excluded)	Open	Healthy Carious	36 4	0.11	Ref	
	Closed	Healthy Carious	118 76	0.64	5.8	2.0-17.0
S/R (29 restored sites excluded)	Open	Healthy Carious	119 8	0.07	Ref	
	Closed	Healthy Carious	104 20	0.19	2.7	1.1-6.4

*Adjusted for time since eruption of first tooth, brushing frequency, use of fluoride supplements, current use of nighttime bottle, and country of birth of primary caregiver.

Discussion

The authors have tested the hypothesis that the odds for proximal caries at posterior interproximal sites in the primary dentition with closed contact points are greater than odds for proximal caries at the same sites but with open contact points. The data support this hypothesis consistently for all relevant contact points. The increased odds for untreated caries at the lower left canine/first molar interproximal site was not significant. Nevertheless, it is important to recognize the study limitations, which primarily concern the evaluation of the open/closed status of the contact point, the nature of the sample, and the cross-sectional study design.

If the results of this study are supported by future work, then the implications are important, especially with respect to caries management in the primary dentition of high-risk groups. A number of studies have demonstrated the benefit of periodic professional flossing with a combination of fluoride and/or chlorhexidine gels in terms of reduced approximal caries incidence in adolescent[10,11] and preschool[12] children. The regimes in all of these studies were 4 times yearly and all used dental assistants or nurses enabling a reduction in program costs. In view of the doubtful effectiveness of interdental cleaning used as a population strategy (ie, performed by people themselves rather than

by a professional of some kind) to prevent/manage periodontal disease[13] and the fact that such techniques have never been evaluated in terms of caries prevention, the use of such professional programs and interventions among high-risk groups may be a means of preventing caries. In this context, it is also important to note that in this study using parental self-reports, approximately 72% of parents responded that they never floss their child's teeth, and only 17% do it daily. Encouraging the use of home flossing in high-risk children would probably be a very difficult task with doubtful effectiveness.

In addition to the possibility of interdental cleaning, the application of fluoride to the posterior interdental spaces of high-risk children may be a useful means to prevent proximal caries in this group. The question would then be whether it would be appropriate to apply fluoride to all posterior contact points in high-risk children or only apply it to contact points that are closed. Bearing in mind the transitory nature of the open or closed status of the contact points (many contact points evaluated as open will become closed due to eruption and growth) and that appropriate follow-up of the child to reassess the need to apply fluoride to the contact points in question may be difficult, application of fluoride to all posterior contact points in high-risk children would probably be most appropriate. However, all this remains to be investigated formally using appropriately designed clinical trials.

Beyond the principal results of the study, it is important to note other variables that were associated with proximal caries in this sample. Those children whose teeth were brushed less than once a day, those who had never used fluoride supplementation, those currently using a nighttime bottle, and those children with parents born outside Canada had increased odds for proximal caries. These results were consistent across interproximal sites and are in agreement with previous research.[14] It is to be expected that not all expected variables are related to caries, because the analyses concern factors associated with caries at various individual interproximal sites rather than indicators of total caries experience. Another explanation is that some of the variables (eg, family revenue) were not answered by many subjects, and others (eg, time since eruption of first tooth and flossing frequency) may have questionable validity.

The authors used a pragmatic approach that they felt would result in the least measurement error. While the subjective nature of the evaluation needs to be recognized, the extremely good consistency of the figures for proportions of each contact point open and closed demonstrated in Figure 1 give some support to the reliability of the form of evaluation used in this study. Another aspect of the validity of evaluation of contact points concerns the observation that some contact points categorized as open and with untreated caries may have been closed at the time of the initiation of the lesion, but the contact point had subsequently been destroyed with the development of the disease. However, this is a conservative error in the sense that it would push the hypothesised association toward the null.

An additional contact point status validity issue is the fact that the inclusion criteria permitted subject and interproximal contact inclusion as soon as the subject had the second tooth in 1 or more of the relevant contact points visibly erupting. This meant that some contact points were included when the second tooth was only partially erupted, therefore giving an open contact point with at least 1 tooth having less risk to be carious simply because of its shorter time period in the mouth. To minimize this source of bias with respect to the hypothesis, analyses were site-specific and controlled for the time since the eruption of the first tooth into the mouth through the use of the "age-at-eruption-of-first-tooth" indicator. Another aspect of concern with variable measurement was the caries assessment. This was performed by one clinician blinded to the study hypothesis at the time of evaluation. The use of a single evaluator reduces interrater error but also reduces generalizibility.

With respect to the nature of the sample, it was a high-risk group for dental caries. At this first-level investigation of the study hypothesis, the authors wanted to have children at high risk of caries so as to have a large number of lesions in a relatively small sample. Hence, only those children with at least 1 carious lesion were included. This is, therefore, a limitation on the generalizability of the results, wherein a different pattern of caries may occur in children at low risk for caries. In this context, it is important to recognize that the pattern of intraoral caries distribution in the permanent dentition is different in high- and low-risk groups.[3] Finally, there is the cross-sectional design of the study, which means that no conclusions concerning the temporal relationship of the open/closed status and the caries status of the contact points can be drawn.

Conclusions

The findings of this study suggest that, in the posterior primary dentition of children at high risk for caries, those interproximal sites with closed contact points are at greater risk for caries than those with open contact points. If this finding is confirmed in future work, there are important implications for individual and public health-based caries prevention interventions and programs.

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Abstract of the Scientific Literature

Drug-induced Gingival Overgrowth

Clinically significant, drug-induced gingival overgrowth is frequently observed as an unwanted side effect of specific medications. The purpose of this manuscript was to appraise the various risk factors that have been associated with drug-induced gingival overgrowth. Age, gender, drug variables such as dosage and dosage/body weight relationship, drug type and characteristics, concomitant medication, periodontal variables such as plaque scores and gingival inflammation, and genetics are discussed. It may be concluded from this manuscript that oral hygiene and drug alternative regimens can help reduce the impact of this unwanted side effect.

Comments: The increasing number of children with successful organ transplants has significantly increased the chance to encounter children with drug-induced gingival overgrowth in our clinics. Both for patients and clinicians, it would be desirable to know the likelihood of developing drug-induced gingival overgrowth, based on the factors related to its appearance and severity, allowing practitioners to take measures that would minimize the chance of its appearance and reduce its severity. **EBG**

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